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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

NOVEMBER 14.

Institute of Metals (Birmingham Local Section):—Meeting at the James Watt Memorial Institute, Birmingham, at 7 p.m. "Deoxidisers and Fluxes," Paper by G. L. Bailey.

Institute of Metals (Swansea Local Section):—Meeting at Y.M.C.A., at 6.15 p.m. "Ageing and Age-Hardening," Paper by Cecil H. Desch.

Institute of Marine Engineers:—Meeting in London, at 6 p.m. "Welding for Pressure Vessels," Paper by R. Sulzer.

NOVEMBER 16.

Manchester Association of Engineers (Students' Section):—Meeting, at 7.30 p.m. "The Testing and Inspection of Important Forgings and Castings," lecture by R. W. Bailey.

NOVEMBER 17.

Institution of Welding Engineers (Midlands Branch):—Meeting at Birmingham. "Stainless Steels and their Treatment," Paper by F. Leverick.

Institute of British Foundrymen.

NOVEMBER 15.

Birmingham, Coventry and West Midlands Branch:—Meeting at Birmirgham, at 7.30 p.m. Works visit to the Midland Electric Manufacturing Company, Limited.

NOVEMBER 17.

Sheffield and District Branch:—Meeting, at 7.45 p.m. "The Production of Oxygen and Dissolved Acetylene, and their Uses in the Foundry," Paper by E. Seymour Semper.

NOVEMBER 18.

East Midlands Branch:—Meeting at Loughborough College, at 6 p.m. "Photo-Micrographs and their Interpretation." Paper by Dr A. Bramley.

Cupola Development.

The lecture recently given to the French founders by the Director of the British Cast Iron Research Association represents another stage in international foundry interchange, apart from the regular exchange Papers. The French have had several such Papers and in this country we have had contributions by such authorities as Dr. Vanzetti, and recently Mr. Russell, of Melbourne, and M. Ronceray has in the past lectured to most of the I.B.F. branches. Except for one by Mr. V. C. Faulkner, Mr. Pearce's Paper is the first from this country, and, like all such Papers, the invitation to give it is a compliment not only to the author but to the country of his origin.

It may be taken at any rate as evidence of the interest aroused by British developments. It is particularly interesting that the cupola should be concerned, because French opinion with respect to this furnace tends to prefer the simplest possible design operated in the simplest possible way. In support of this preference, cases can be quoted in which such furnaces work on comparatively low coke ratios. These cases, however, merely serve to throw into sharper relief the majority which operate on much higher coke consumptions.

Many attempts are made to relate the operation of the furnace to the principles of combustion of carbon, but we are far from convinced that this is a profitable line to work on. We do not believe that sufficient is yet known about the combustion of carbon and the way in which the two oxides of carbon are formed from the original material and their relationship with each other, particularly in the presence of excess air on the one hand and excess carbon on the other, to enable these principles to be applied to cupola operation. The lack of equilibrium in the gases of combustion at any given moment makes arguing from gas analyses extremely dangerous. The best criterion is whether the furnace works and with what results with respect to temperature and coke consumption. The next step forward is likely to come from further light on this question of the combustion of carbon, which is indeed fundamental to all metallurgical operations.

Technical Control in Small Foundries.

Since science is making such progress in the foundry industry, we are constantly being asked as to what steps the smaller establishments should take in order to provide a sound basis for expansion. It is not an easy question to answer, but certainly a start should be made by joining the Employers' Federation and the technical organisations of the industry. The first factor in control is the purchase of weighing machines. This may sound elementary, but cupola stages still exist without such an essential item in control. Records must be taken of everything possible, which obviously involves the introduction of a simple costing system. This may involve a fair amount of night work for the foreman, but it is worth while. Then notes should be made of each cast, expressing in simple terms the type of scrap, any noteworthy difference, the temperature of the metal—"hot," "very hot," and similar terms. For facing sand the make-up for grades of castings should be regularly filed, while sketches should be made of the methods of gating difficult jobs. In plain English, any big variable such as a change in the supply of coke or sand should be noted from as many angles as possible.

The great factor to be avoided is sheltering behind the phrase, "that depends." We have personally investigated troubles in one small foundry, and to every question we asked, we received the non-commital reply of "that depends." The amount of coke used *depended* upon the quality of the scrap, the quantity and quality used *also depended* upon the type of scrap available, the facing sands *depended* on what the casting had to be used for. Nothing was recorded and nothing was standardised, whilst everything was left to the judgment of the few operatives engaged. It is a good policy for the smaller foundries so to arrange their affairs that they are in a position to answer every question that could possibly be posed by an outside consultant, and if they can achieve such an ideal, it is highly probable that the services of such will never be required. A final factor in control is to be perfectly sure that an adequate supply of spare parts is maintained.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Early Roll Founding.

To the Editor of The Foundry Trade Journal.

Sir,—In the course of his address on "Early Roll Founding," Mr. Harold E. Cookson is reported on page 251 of The Foundry Trade Journal of November 2, 1933, as saying: ". . . . at this time (1796) there was also a roll foundry at Hayle, in Cornwall, but no data are available." The following notes may be of interest. The rolls manufactured at Hayle were for the "Cornish Crushing Rolls," a machine introduced early in the 19th century by Richard Trevithick to the copper mines of Cornwall for breaking into small pieces the larger stones of ore.

One of these stone-crushing mills was put up by him in Dolcoath Mine about 1804, and was spoken of as the first ever used for such a purpose. It caused a great saving compared with breaking by hand hammers. About the same time, while going through one of the Staffordshire china manufactories, Richard Trevithick is reported to have said to the manufacturer, "You would grind your clay much better by using my cast-iron rolls and high-pressure steam engine."

The references to these early crushers speak of cast-iron rollers, but later they are described and spoken of as not having improved much from the original models and then chilled cast iron is the material used for the rolls. The following description is of a machine of the early "seventies": "The crushing rolls are a pair of chilled cast-iron rolls 24 in. dia. and 16 in. or 18 in. long, fixed horizontally side by side and driven at about 8 r.p.m. One of these rolls is coupled to the main driving shaft, and the other, which is driven from it by gearing, is mounted upon sliding bearings and pressed up against the fixed roll either by two weighted levers or in some cases by springs, the object being to allow any extra-large stone or foreign substance to pass through without injury to the rolls. Each roll consists of a cylindrical hoop cast with the centre hole octagonal and secured upon the spindle by wedging and cottering, so as to admit of being readily renewed when worn out."

By the "eighties" steel rolls were used and a Cornish crusher with steel rolls adapted for either fine or coarse grinding was shown by Messrs. Harvey, of Hayle, at the Mining Association and Institute's eighth exhibition at Camborne in July, 1888. The Hayle Foundry was not only a roll foundry, as one would gather from the remarks of Mr. Cookson, but one which provided a large proportion of the cast-iron work for the neighbouring copper and tin mines. It was established by Mr. John Harvey about the year 1775 for the manufacture of cast-iron pipes for mine pumps, to supersede the wooden ones in use up till then, and also to save expense of transportation of castings from Wales and the Midlands for use in the steam engines of the mines. In the 1790's James Watt had parts of his engines cast at Hayle, and in 1801 the castings for the first locomotive engine built by Richard Trevithick at Camborne came from his father-in-law's foundry at Hayle. At this period the Hayle Foundry was one of the foremost in the kingdom, and in 1843 had the honour of casting the largest steam cylinder ever constructed up to that time as one casting, viz., 144 in. dia. and weighing approximately 25 tons. The firm also produced many notable engines during the last century; at one time three-quarters of the water supply of London was raised by Harvey & Company's engines built at Hayle, and the firm also supplied the pumping plant for the Severn Tunnel, and finally, after a century and a-quarter of useful work, closed down in 1903.—Yours, etc.,

41, Roskear Road, Camborne. T. R. Harris.

November 3, 1933.

The Foundrymen's International President.

Mr. W. Maas Geesteranus was born in 1893, and received his technical education at the University of Delft, from which he graduated with honours in 1918. He was appointed mechanical engineer in the State Munition Works, and here he was able to satisfy his deep interest in the subject of metallography. Already at that time, however, his inclinations were towards private enterprise, with its greater liveliness and its technical and commercial possibilities.

In 1919 he entered the services of Messrs. Werkspoor, Limited, of Amsterdam, who own a well-known engine works in that city and a wagon- and bridge-building works in Utrecht. He was appointed works superintendent, which gave him every opportunity to study and solve the many technical problems presented by the large foundry which forms part of these works.

Mr. W. Maas Geesteranus
(President, International Committee of Foundry Technical Associations).

Mr. Maas Geesteranus was made manager of the Amsterdam works and assistant managing-director of Werkspoor in 1931. His direct contact with the foundry naturally could not be maintained to the same extent in his new position, yet at the same time he remains keenly interested in its problems and its progress.

It was therefore to be expected that Mr. Maas Geesteranus would occupy a prominent position in the Dutch Society of Foundry Technicians. In 1929 he was appointed chairman of this society, which office he has held continuously since that date. In this capacity he is a member of the "Comité Internationale des Associations Techniques de Fonderies" (the International Committee of Foundry Technical Associations), and during the year 1933 he occupies the chair in this committee.

Steelworks Laboratories.—In the "Memoires de la Société des Ingenieurs Civils de France," P. Chevenard deals with the organisation and equipment of a modern steelworks laboratory.

Centrifugal-Castings of High-Chromium Steels.—According to Dr. F. M. Becket, of the Union Carbide and Carbon Research Laboratories, Long Island City, N.Y., the centrifugal casting of high-chromium steels makes possible the casting of large tubes from compositions which at present cannot be fabricated into seamless tubing. By the centrifugal process larger tubes have been made than those obtainable from the high-chromium steels capable of being pierced into seamless tubes. Tubes have been centrifugally cast containing about 25 per cent. chromium, 12 per cent. nickel and 0.30 per cent. carbon and having a diameter of 13 in., a wall thickness of $\frac{5}{8}$ in. and a length of 12 ft. They are in use in a chemical process operating at 1,000 deg. C. (1,832 deg. F.).—"Iron Age."

Random Shots.

Just as "Marksman" paused to sign the register at the Central Station Hotel, Newcastle, a few days ago, he was hailed vociferously and turned around to be accosted by one of the four compères of the Gee Kaye-Haitch Cabaret Show. It was night time and the hotel was stiff with important-looking men in dress suits, and the two foundrymen felt very isolated amidst all this dignified exuberance. It was the night porter who enlightened them—the Coke-Oven Managers were enjoying *their* annual conference. "Aha!" said our compère maliciously, and reminiscently of our 1932 convention, "Another nerve-racking time for you in the wee sma' hours?"

"Oh, no," returned the night porter feelingly, "these are respectable gentlemen, sir!" Ah, well, compères gather no moss, it seems.

* * *

"Marksman" was *en route*—his peregrinations are truly remarkable and cause that unhappy mortal to be the victim of much *ennui*. Even the most enthusiastic busmen would find the proverbial holiday pall, if continuously indulged in of necessity, even, indeed, if it did not ultimately become completely nauseating. Time was when "Marksman's" enthusiasm to see a new foundry propelled him even hundreds of miles. Now, however, his appetite is somewhat jaded, his desires dulled, and a still unvisited foundry is to him—just another foundry.

* * *

Since his first acquaintance with the bizarre plant and fantastic technique of the renowned Gayway Foundry, "Marksman" has become *blasé* despite the exotic charm of Miss Snookers and her staff, and each recurring visit to that industrious institution has only served to confirm his previous conviction that there he has seen the whole that founding, and foundries, had to offer, and thus when, on leaving Newcastle, he turned his extraordinarily large feet and bulging eyes in the direction of still another foundry, he expected just nothing and firmly decided not to be disappointed.

* * *

This foundry was all that a foundry should be—well lighted, lofty, spacious and well ventilated—and "Marksman's" accustomed eye roved around noting the evidence of careful management and skilful operation. The tidy arrangement of the machines, the orderly progress of the work, the provision of the best and latest equipment—each received its due meed of his unspoken praise. As he turned to leave this busy and efficient foundry, "Marksman" inquired of his guide the reason for the dozen or so wooden boxes, which, fastened high up, broke the virgin expanse of the whitewashed foundry wall. Even these boxes were orderly and regular—in keeping with the rest of the place. "Birds," replied the guide laconically. "Ahem!" said "Marksman," his thoughts flashing back to dear Miss Snookers and her Gayway Foundry, and then—"Jumping test-bars! Look at 'em!" as a small flock of sparrows swung into the foundry, and selecting each its own nesting box, so thoughtfully provided by the management, demonstrated once again the immortal truth of Marcus Aurelius that "there are birds *and* birds."

"Marksman," a keen reader of Maeterlinck, believes them to be spirits of departed foundrymen whom fate compels to revisit the scene of their earthly labours, to be released from their earthbond only when the perfect casting is poured.

Such simple truth is really touching.

Marksman.

Cast Iron Suitable for Nitrogen Hardening Nitricastiron (Centrard).

By J. E. Hurst.

(*Concluded from page* 247.)

Protection of Surfaces.—Very frequently articles for case hardening require some surfaces to be left soft for subsequent machining operations, the cutting of threads, keyways, etc. The protection of such surfaces from the hardening effect is commonly done by tinning. Pure tin or tin solder is generally used for this purpose. Although such solders melt at a lower temperature than the nitriding temperature, a sufficient amount will adhere by reason of surface tension, and will supply ample protection. In the application of tin the parts are thoroughly cleaned and a flux of hydrochloric acid (killed) applied. The articles are then dipped into a bath of molten solder or tin and kept there sufficient time for the tin to adhere. The excess of tin can be shaken or brushed off with a wire brush on removal from the bath.

Nickel plating to a depth of 0.0005 in. has

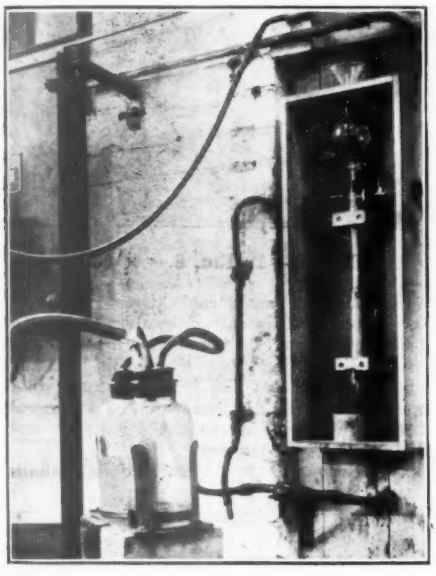


Fig. 6.—View of Exit End of Nitrarding Furnace, showing Dissociation Tester.

been found effective in preventing the nitriding. Experiments have been made with protective paints. Positive results have been obtained with paints made up of stannous or stannic oxides. These compounds decompose in the nitriding furnace to form tin. Another protective paint consists of powdered aluminium and sodium silicate. This is applied with a brush to the surfaces to be protected and then allowed to dry. A hard coating is formed which can be removed after Nitrarding by boiling the articles followed by scratch brushes. The most recent type of protective paint consists essentially of a mixture of finely powdered lead and tin suspended in an oily vehicle of animal oils. This can be applied to the articles by means of a brush or spray pistol. The fine coating of powdered lead and tin thus obtained on the surfaces melts at the nitrarding temperature, and thus exercises the same function as the solder applied in the manner previously described.

The Nitrogen Hardened Surface.

The alloy, both when sand-cast and when centrifugally-cast, gives hardness and depth of penetration values somewhat lower than those of standard Nitralloy steel LK3 Grade; the degree of hardness attained and also the depth of penetration in the centrifugally-cast specimens are slightly greater than those of the sand-cast specimens.

Illustrations of the structure of the hardened layer are given in micrographs (Figs. 7, 8, 9 and 10), which have been chosen from several typical specimens of the alloy material. Fig. 7 shows the structure of a sand-cast specimen, and Fig. 8 that of a centrifugally-cast specimen. The nitrogen-hardened layer in both cases etches darker than the core with picric acid. The carbides exist in the hardened case apparently undecomposed, and an extreme outer layer which etches lighter than the hardened case can be clearly seen under the microscope, and is visible in Fig. 8. Fig. 9 shows the same specimen as Fig. 8 at a higher magnification. The extreme outer layer is clearly visible in this illustration, as are also the free massive carbides, the small specks of deposited carbides and the darker etching of the ground-mass constituents. It is of general interest to note that some of the massive carbide areas in the nitrogen-hardened portion show one or more rectilinear markings in a direction at right angles to their longest axis. None of these carbide areas in the core appears to show these markings. Immediately underneath the extreme outer layer is a concentration of specks of a third constituent. This appears to be characteristic.

In all the specimens examined, the nitrogen hardened surface is quite coherent and is not easily flaked or spalled. Under the microscope the polished surfaces of the hardened specimens show numerous small cavities. These are due to the presence of the free graphite in the surface, and are illustrated in Fig. 10, which also shows a typical diamond hardness impression. The complete absence of spalling is demonstrated by this impression. The ring-form specimens used in the testing procedure are of rectangular cross-section, but in testing them no sign of flaking or spalling occurs even at the extreme corners of the section until stresses closely approximating to the breaking stresses are attained.

Table II.—*Comparative Hardness Figures of Various Alloys.*

	Brinell hardness Firth diamond 10 kg. load.
Nitralloy steel, nitrogen hardened ..	900 to 1,100
Nitricastiron, nitrogen hardened	900 to 1,100
Nickel chrome cast iron, hardened and tempered	450 to 500
Chrome vanadium steel, carburised and hardened	750
Hardened high speed steel.	675
Straight carbon steel, hardened	650
Chrome magnet steel hardened	627
Rustless steel, hardened	600
Chrome-nickel steel, hardened	555

An interesting comparison of the hardness figures for nitrogen hardened materials with those obtainable for other hardened materials is set forth in Table II.

Preparation for Treatment and Rectification after Treatment.

Whilst for certain purposes articles can be treated in the "as-cast" condition after a good sand blasting to remove all traces of scale and dirt, for the most part the case hardening treatment is applied to articles in the finished machined condition. It will be realised that the nitrarding treatment consists of a single operation of treating under the prescribed conditions at a temperature of 500 deg. C., a temperature which is below that of visible red. No further treatment is necessary, so that articles after the single case hardening treatment may be put to immediate use.

The following general details of procedure in the preparation of Nitricastiron articles for treatment may be of interest:—

(1) Rough machine to remove bulk of the material, leaving ample allowance on all surfaces to accommodate any distortion which may occur during the stabilising treatment. Good radii should be left everywhere and all corners should be well rounded. It is advisable to retain as much bulk of material as possible on surfaces not required to be hardened until after the hardening operation in order that the part shall be as rigid as possible during the hardening treatment.

(2) Stabilise by heating to a temperature of 550 to 600 deg. C. for a period of from ½ to 6 hrs., according to size and complexity of the casting. This treatment can be followed by cooling freely in still air. The intention of this treatment is to allow of the part to take its

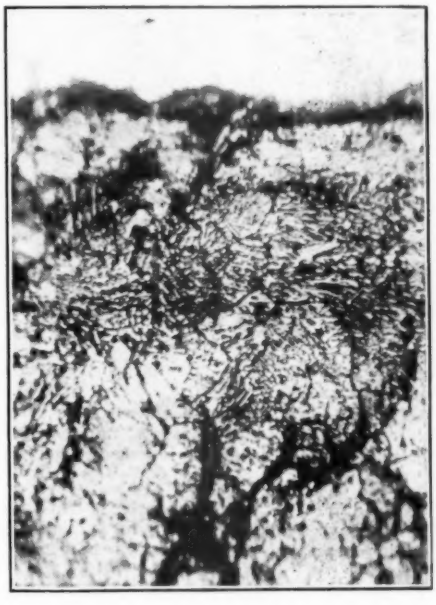


Fig. 7.—Sand-Cast Nitricastiron. Nitrogen-Hardened Surface. Etched. × 600.

definite set to avoid and minimise distortion which might occur in subsequent nitrarding. After this treatment the parts should be examined, and if appreciable deformation has occurred the parts should be rectified at this stage and re-stabilised.

(3) Finish-machine and grind surfaces required to be hardened. If surfaces not required to be hardened are to be protected by tinning, this operation may be done prior to finish-machining in order that any tin adhering to the surfaces required to be hardened can be removed in the finish-machining operations. If protection is carried out by painting then this can be done after finish-machining and grinding.

(4) *Nitrard.* The nitrarding process leaves no scale, but merely a dull matte film which can be removed by buffing or lapping or rubbing with fine emery.

Very slight changes in dimensions only occur after this operation, so that normally parts are quite satisfactorily treated after finish grinding or honing processes. In those cases where intense accuracy of dimensions is required in the finished parts, allowance for the slight change

in dimensions and subsequent rectification can be made in the finish machining operations. The actual allowance to be made will depend upon individual circumstances, and in all cases is best determined by the trial of an actual part.

(5) Final rectification can be done by grinding or honing, and in these instances the amount of

Fig. 8.—Centrifugally-Cast Nitricastiron. Nitrogen-Hardened Surface. Etched. × 200.

material removed from the hardened surfaces should not exceed 0.002 in.

(6) Where finely-polished surfaces are required, it is essential that the surface should be finely polished prior to the hardening operation.

Some Applications of Nitricastiron.

Many different types of castings in this material have been produced already, both by centrifugal-casting and ordinary sand-casting

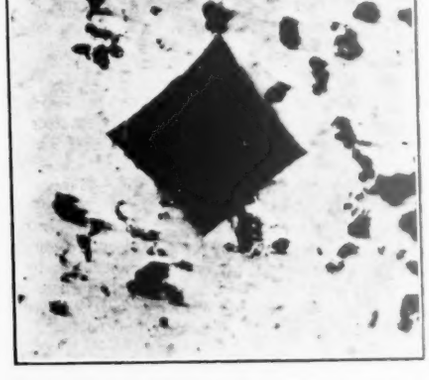


Fig. 10.—Firth Diamond-Hardness Impression, Nitrogen-Hardened Surface. × 110.

methods, but by far the largest commercial application at the present time is the production of cylinder liners. Large numbers of Nitricastiron (Centrard) liners have been fitted to various types of petrol, oil and compression ignition engines, and many of these have been in service for considerable periods. Full details of the determination of the resistance to wear of Nitricastiron cylinders under actual engine running conditions have been published by the writer in a Paper* before the recent meeting of the Iron and Steel Institute.

In deciding upon the experimental procedure, it was considered that the available types of abrasion wear-testing machines were not likely to give results of value in determining the comparative resistance of materials to wear in engine cylinders. For this reason the experiments were carried out under actual engine cylinder conditions. To obtain results of a decisive character the tests under these conditions were of very prolonged duration and actually occupied over three years, during which several individual engine tests were conducted over a running time period equivalent to 40,000 miles road running. Other tests were carried out under actual road-running conditions for a similar duration. The experiments undertaken clearly duplicate actual industrial conditions, a point which is of tremendous importance when dealing with such a complex property as the resistance to wear.

In the experiments, cylinder liners of nitrogen-hardened cast iron whose surface hardness was recorded at approximately 1,000 Firth diamond hardness were compared with liners of plain unalloyed cast iron, chromium alloy cast iron and nickel-chromium cast iron, both of these latter being tested in the "as-cast" and hardened and tempered condition. The approximate hardness of these materials was 230 to 260 Brinell for the ordinary and chromium alloy cast iron in the "as-cast" condition and 480 to 500 Brinell for the materials in the hardened and tempered condition. All tests were carried out for periods of 10,000 miles or multiples of this period, and the cylinder wear was determined by a comparison of the maximum diameter after the test with the original diameter of the cylinder bore. Following a now common and well-understood practice, the maximum wear was expressed in miles per one-thousandth of an inch wear, obtained by dividing the total miles by the maximum wear expressed in thousandths of an inch.

A strict comparison of the results obtained can be made only on the basis of equal mileages. At a mileage of 30,000 the resistance to wear of nitrogen-hardened alloy cast iron compared with ordinary cast iron as used normally for cylinder liners was as 2:1 and compared with chromium-alloy cast iron as 2.6:1. At a mileage of 40,000 the ratio of nitrogen-hardened to chromium-alloy cast iron still remained the same at 2.6:1. These results refer to tests carried out in a stationary engine. In actual road tests, whilst the wear value in miles per 0.001 in. of wear was smaller in magnitude, at a mileage of 40,000 the ratio of nitrogen-hardened to the hardened and tempered chromium alloy was found to be as 2.2:1, a figure in close agreement with the stationary engine tests. In the actual wear values the nitrogen-hardened cast iron showed results of from 10,000 to 32,000 miles engine running for a wear of one-thousandth of an inch cylinder diameter. A matter of some interest was the fact that the differences between the wear values of ordinary cast iron, alloy cast irons in the "as-cast" condition, and hardened and tempered cast irons were not of a very large order.

The experiments clearly demonstrate the improved wear-resisting properties of the super-hard nitrogen-hardened cast iron under internal-combustion engine-cylinder conditions. They may be used also to demonstrate the stability of the nitrogen-hardened surface under these same conditions. A short experimental test was made with petrol doped with Ethyl fluid. No effect due to the presence of this fluid was observed.

There are several aspects of the strength properties in which Nitricastiron is distinctly different from other types of cast iron, and which have an important bearing probably on the behaviour of this material in service under engine-cylinder conditions. Apart from the high-tensile strength, the high modulus of elasticity is indicative of a high resistance to elastic deformation, and the low permanent-set value is indicative of a high resistance to permanent

Fig. 9.—As Fig. 8. × 600.

deformation. A considerable portion of cylinder wear is undoubtedly caused by deformation, due to stresses set up by the piston at the points of reversal in direction. From this point it is to be expected that the high resistance to deformation of Nitricastiron would be favourably reflected in increased resistance to wear under engine-cylinder conditions.

The nitrogen-hardened surface is definitely

Fig. 11.—Ordinary Cast Iron and Nitricastiron after exposure to Atmospheric Corrosion for 9 Months.

corrosion resisting and from this point of view is considerably superior to ordinary cast iron. This property is one which is likely to prove of value in engine-cylinder liners. In several cases already liners have been manufactured

* Foundry Trade Journal, September 21, 1933, page 163.

hardened externally as well as internally with the object of providing some resistance to corrosion on the cooling water side. The illustration, Fig. 11, shows two specimens, one of ordinary grey iron and the other of Nitricast-iron, after exposure to the works atmosphere for a period of nine months. The high degree of resistance to corrosion of the Nitricastiron sample is clearly demonstrated. A further aspect, which is of some importance in considering the applications of Nitricastiron, is the ability to reharden parts which have become worn without running any risk of damage to machined surfaces, keyways and threaded holes. These surfaces, not required to be hardened, can be protected, and there is no sealing or reheating and the hardening itself is conducted at a low temperature, risk of damage is completely eliminated.

Nitrogen-Hardened Austenitic Cast Irons.

The most recent development in the process of nitrogen-hardening cast iron is the extension of this process to certain austenitic cast irons. Patent protection for this has been applied for. As is well known, certain austenitic cast irons possess a valuable property in that they have a high coefficient of expansion. This high coefficient of expansion renders the austenitic cast irons extremely valuable for use in conjunction with aluminium alloys, and they are the subject of great interest to the internal-combustion-engine designer desirous of utilising aluminium alloys for the production of cylinder casings. By treatment with the nitrogen-hardening process in accordance with the details of this new development, surface hardness of up to 500 Brinell can be obtained, and it is anticipated that this process will have considerable influence in the extension of the use of these austenitic cast irons.

Conclusion.

It will be agreed that the ability to produce surfaces superhardened in the manner described in alloy cast iron is a discovery of far-reaching importance in the field of the metallurgy of cast iron. In its further development it cannot fail to find innumerable applications in the construction of wearing parts in all types of machinery. Already the application of this material to cylinder liners is giving results beyond the imagination of engineers even three or four years ago. The facility of hardening castings in this manner is one of the several developments in this field which have done so much to place the metallurgy of cast iron on the level of that of its more elegant sister, the metallurgy of steel.

DISCUSSION.

The CHAIRMAN said that although the author had dealt very fully with the subject of nitricastiron there would probably be a number of points upon which the members would wish to seek further information. He thought the Paper worthy of more thought and study than was possible at that moment, and he believed that when they were able to read the Paper in THE FOUNDRY TRADE JOURNAL they would find it of the greatest value and well worth minute consideration.

DR. J. W. DONALDSON said that he thought the first duty was to congratulate MR. HURST upon the valuable discoveries he had made in connection with the nitrogen hardening of cast iron. The nitriding process opened up wide possibilities in regard to wear-resisting cast irons. The treatment put cast iron on the same plane as the steels. He noticed in the table of mechanical properties which the author gave, the treatment before nitriding was shown as heating to 900 deg. C. and cooling in air or oil. The cooling was actually an air-quenching, and he was rather surprised at the results, because the analysis given showed 1.6 per cent. chromium, and that was rather a low percentage to give such a large hardness. MR. HURST referred to the depth of penetration of the nitrided material and mentioned that there was an outer case of approximately 1-1,000th of an inch of extremely hard material followed by 10- to 16-thousandth of material with a Brinell hardness of 1,000. He would like to know if that figure was obtained after the extremely hard part had been removed. MR. HURST had not made any reference to the heat-resisting properties of Nitricastiron, and he would be very interested to hear from MR. HURST how the material behaved in regard to heat-resistance and especially how they compared with nickel-chromium heat-resisting irons.

MR. J. E. HURST, in reply, said that the Nitricastiron, as a result of the treatment stated, was only very lightly quenched and did not show very much air-hardness. Regarding the outer layer of 1-1,000th of an inch, he was afraid he may not have made the position quite clear. The outer layer was not hard but friable, and could be removed with a knife without difficulty; the Brinell number given was after the outer layer had been removed. He regretted that so far he had no information as to the heat-resisting properties of the material; he had not yet investigated that aspect of the material.

MR. N. MCMANUS said that he noticed in the tables shown that the irons used contained 2.68 per cent. carbon. Was it to be understood that all irons for the nitriding treatment had to be of 2.68 per cent. carbon?

MR. J. E. HURST said that all his experiments had been made on iron having a total carbon of 2.68, and it was advisable to keep the carbon low, although it did not necessarily follow that it must be kept at that particular figure.

MR. A. CAMPION said that he joined with MR. Donaldson in congratulating MR. HURST upon the valuable research work which he had carried out and the results obtained. He had intended raising the point which MR. MCMANUS had mentioned, not in regard to the carbon alone but the composition generally. The type of iron used for the purposes for which Nitricastiron was recommended was, as a rule, low-carbon, close-grained material. He thought the composition of the iron was sure to have some influence on the process, and he would be glad to learn from MR. HURST if he had any data showing the influence of silicon and manganese and also of the sulphur and phosphorus. He would like to have an idea of the range of compositions which were suitable for nitriding. He remembered a case of a chemical works about 35 years ago where it was desired to convey ammonia gas through a certain part of the plant, and the difficulty was to find a material which would last for more than a few days. Copper, brass, lead and many other metals and alloys were tried without success. Cast iron was not thought of in those days, when, even if it had been, cast-iron pipes were all too heavy. Wrought iron was tried, and, although better than the other materials, did not last very long, and he thought that indicated that there must be a minimum of carbon permissible in the material for successful nitriding. All the examples which MR. HURST had shown were of small castings; he thought 36 lbs. was the largest mentioned, and he would like to know whether the process was applicable to larger castings, such, for instance, as a marine Diesel-engine liner of 380- to 500-mm. bore. Was any trouble experienced with excessive volume change in very complicated castings or did the distortion become greater than in ordinary iron? The process was exceedingly interesting, and personally he did not know what the action really was; he wondered if MR. HURST could give the theory of the process.

MR. J. E. HURST, in reply, said the effect of composition is of great importance, but he had not yet thoroughly investigated it. The effect of silicon, phosphorus and manganese was being studied, but it was too early to give the details. The composition approximately as given in the tables was that which had given the best results so far. It was quite possible to obtain good results with various compositions, and he had been successful with material containing 3.0 to 3.2 per cent. of carbon. The largest cylinder liner so far made was about 10 to 12 in. dia. In the case of complicated castings, distortion was bound to occur and might cause trouble, but they relied on the skill of the operator to cope with it. Distortion took place in the quenching of ordinary material, and in Sheffield they had for long enough dealt with it. In regard to the mechanism of the nitriding process, he refrained from theorising at the present time.

MR. F. HUDSON said that he had been rather interested in Nitricastiron and alloy steels in regard to corrosion and wear. Leading up to what he wished to say, he would mention the report recently issued by the Institute of Automobile Engineers in relation to cylinder wear, in which it was stated that wear was due to corrosion and not to erosion. He was not surprised at that finding from his experience of hydraulic work. Materials having a good resistance to corrosion were rather soft for such work as, for instance, Staybrite. It looked as if Nitricastiron was in a favoured class as being reasonably hard and of good corrosion-resisting properties, and he had hopes of good results. In regard to the composition, he thought they should consider the effect of graphite on corrosion-resisting properties. In the Brown-Firth pamphlet it is reported that Nitralloy steel corrosion is accelerated by the graphite packing. He should therefore expect that Nitricastiron would be less resistant to corrosion than Nitralloy steel. He had made some experiments and found the following results: Ordinary cast iron, 6.1; Nitricastiron, 6.7; Nitralloy steel, 0.13. The fact of Nitricastiron corroding so rapidly had disappointed him, and he would like MR. HURST's views on it and also as to the influence of graphite on corrosion. In ordinary water Nitricastiron was rather better than ordinary iron, but in sea water it was very disappointing in comparison with Nitralloy steel.

MR. HURST said that MR. HUDSON's comments were of such a nature that he thought he was entitled to ask for notice and to be allowed to reply in writing. Corrosion covered a multitude of conditions and he did not claim that Nitricastiron was resistant to every form of corrosion imaginable. Certainly in the case of Nitricastiron liners the surface exposed to water had given excellent results and had been awarded many testimonials. He knew of one maker who had so much trouble that he actually went to the trouble of nickel plating the liners, but can now get the desired results by the use of Nitricastiron without plating.

The PRESIDENT said that unfortunately there was other business to be attended to and he had to close the discussion. He thought that everyone present agreed that they had had an excellent Paper and discussion. He asked them to accord to MR. HURST a cordial expression of their appreciation of the Paper and for having come to them that day.

At the close of the meeting the members with their ladies and friends adjourned to the Cadora Restaurant, where after tea the evening was spent at cards and music. MR. R. D. LAWRIE acted as M.C.

Vocal selections and recitations were given by Messrs. J. Gibb, Robert Ballantine, W. Lamb (of the Scottish Orchestra) and Miss Young.

MRS. SHARPE, wife of the Junior Vice-President, presented the whist prizes, the first, which she had won herself, and others to MRS. A. LAWRIE and MRS. JARDINE. The gentlemen's prizes were won by Messrs. R. C. Waddell, J. Gibb and W. Smith. MR. D. SHARPE, Junior Vice-President, proposed an omnibus resolution conveying the thanks of the members to artistes, the secretary and all others who had carried out the entertainment.

Titanium and Columbium in High-Chromium Steels.

AIR-HARDENING AND CORROSION-RESISTING PROPERTIES.

In the course of a Paper on "Titanium and Columbium in Plain High-Chromium Steels," read by Messrs. Frederick M. Becket and Russell Franks before the Detroit meeting of the American Institute of Mining and Metallurgical Engineers recently, the authors recall that it is well known that chromium intensifies the hardening effect of carbon in steel; it imparts pronounced air-hardening properties within a rather wide range of chromium content; it provides increased ductility in steels of given strength and hardness; and it enhances resistance to corrosion and oxidation at elevated temperatures to a marked degree. However, in applications requiring a combination of some of these valuable properties great hardness is frequently a detriment rather than a merit. When the objective is a soft and ductile steel having optimum corrosion resistance, the producer strives for a carbon content as low as commercially practicable.

Despite these efforts some of the commercial high-chromium steels low in carbon present considerable difficulties during production, owing to their air-hardening properties, and in consequence the economic result is not favourable. A good example is found in the 5 to 6 per cent. chromium steels employed chiefly in the oil-cracking industry. Steels containing appreciable percentages of chromium are sluggish in their thermal changes, and comparatively long periods are required for annealing. There are many applications in which the plain chromium steels would prove exceedingly useful if greater softness and more ductility could be obtained together with substantial freedom from air-hardening, all without sacrificing resistance to corrosion and oxidation at high temperatures.

With the definite purpose of overcoming the air-hardening tendency and imparting other desired characteristics, an extensive investigation has been made by the authors in which different elements known to have a strong affinity for carbon have been alloyed with steels containing relatively small to large percentages of chromium. Columbium, tantalum, titanium, zirconium, vanadium, tungsten, molybdenum, and other elements have been added in sufficient proportions to combine with the carbon present in the steels; also, each element has been introduced in excess of this requirement in order to determine its effect on the iron-chromium solid solution.

Of the metals employed as addition agents in this investigation, columbium and titanium have proved the most efficacious. One of the marked characteristics of the plain high-chromium steels containing titanium or columbium is the facility with which they may be hot-worked, a result of freedom from the air-hardening tendency. The physical properties of some of the wrought steels containing titanium showed that in the as-rolled condition the low-carbon steel containing about 3 per cent. chromium was comparatively ductile and soft, whereas by reason of air-hardening a 5 per cent. chromium steel was relatively hard and considerably less ductile. Emphasis should be laid on the marked difference in physical properties between the untreated (substantially titanium-free) and the titanium-bearing steels, in the as-rolled condition. As an example, the ductility and softness of a 5.41 per cent. chromium steel containing 0.11 per cent. carbon and 0.75 per cent. titanium are not approached in the as-rolled condition by a steel of similar analysis without titanium.

The properties of the titanium-bearing steels can be further improved through annealing at temperatures between 700 and 900 deg. C.; and, to stress a point of practical importance, this may be accomplished by holding the steels for only a few minutes at temperatures approaching the upper limit of this range. Annealing at temperatures much above 900 deg. C. greatly decrease the toughness, although the steels are not in this way appreciably hardened.

All the steels examined were subjected to the generally accepted corrosion tests. The results disclosed that in steels containing less than about 12 per cent. chromium an appropriate addition of titanium augments the resistance to oxidising media. Less pronounced in this respect was the effect of titanium in the higher chromium low-carbon steels, no doubt because they are inherently more resistant under oxidising conditions.

Tests were conducted under atmospheric conditions embracing titanium-treated and untreated low-carbon 5, 6, 7.5 and 9 per cent. chromium steels. These samples and others of the higher chromium groups were exposed for a long period of time. Briefly, the most important feature uncovered by these tests was that through the agency of titanium there appeared interesting commercial possibilities for a steel containing 7 to 9 per cent. chromium—a steel not completely resistant to staining but one which affords a great measure of protection against progressive rusting. Even without annealing, the combined properties of steel of this class are such as to indicate numerous commercial applications. Plain low-carbon 18 per cent. chromium steels continue to render excellent service in many applications. An improvement greatly desired is increased softness and amenability to deep-drawing operations, particularly by the manufacturer, and the addition of titanium to this steel assists considerably in this direction.

Admittedly all these titanium-containing plain chromium steels present difficulties in welding similar in some respects to those often found in the welding of 18 per cent. chromium-8 per cent. nickel steels containing titanium. Realisation of this problem afforded the stimulus for intensive experimental work in welding the new steels. That the experiments are yielding very encouraging results is all that should now be stated.

It should be emphasised that all the beneficial effects obtained by titanium have been secured also through the addition of columbium, a metal which in the form of a ferro-alloy can be incorporated with high recovery under good melting practice appropriate to the high-chromium steels. Considering the results of the experimental and commercial work performed, the authors consider it reasonable to conclude that titanium or columbium will permit the introduction of a new chromium steel and so facilitate the production of the plain high-chromium steels as to broaden their field of utilisation.

Grain Size and Mechanical Properties of Malleable Cast Iron.

Writing in a recent issue of "Die Giesserei," Dr. Ing. F. Loepelmann reports of the experiments he made with the object of determining the effect of temperature upon the grain size of malleable cast iron, and of finding out the annealing method which gives the best mechanical properties. In preliminary experiments it was found that a reversion of the stability of the graphite, which was postulated by Hanson in his experiments, does not take place. Samples of electrolytic iron and of basic-Bessemer steel wire containing 0.4 per cent. Mn, which were annealed at temperatures between 630 and 760 deg. C. in charcoal powder or methane and then quenched, did not show any cementite or pearlite in the structure. From this the author concludes that, near the pearlite point, graphite remains the stable phase, and that the equilibria found by Hanson were only apparent equilibria.

The effect of temperature upon the grain size was studied with a black-heart iron containing carbon 2.41, silicon 0.99, manganese 0.25 and phosphorus, plus sulphur, 0.1 per cent., and with a white-heart iron containing carbon 2.72, silicon 0.68, manganese 0.12 and phosphorus, plus sulphur, 0.1 per cent., both in the annealed state. To imitate the conditions prevailing in practical service, the irons were heated in sand at 1,150 deg. C. for 20 hrs. Then the temperature was lowered to 900 deg. C. within 8 hrs., and finally to 530 deg. C. within further 140 hrs. At regular intervals test-samples were taken from the furnace, quenched in water and microscopically examined. A considerable grain growth took place during the 20 hrs.' anneal at 1,150 deg. C., the grain size of the black-heart material increasing from 1,290 to 18,500 μ^2. On further annealing at falling temperature, the grain size regularly increased with increasing annealing time, irrespective of the height of temperature. At the end of annealing the grain size was 21,100 μ^2. The larger temper carbon nodules had grown to the cost of the smaller ones, and showed the tendency to extend along the grain boundaries. Similar results were obtained with the white-heart iron. In further experiments it was found that a considerable grain-refinement could be obtained by the following treatment. After annealing the black-heart iron at 1,050 deg. C. for 20 hrs., the temperature was lowered below A_1, then raised again to about 950 deg. C. in order to dissolve the α mixed crystals, and then a test-sample was quenched from above A_1. The grain size, which at 1,050 deg. C. had increased from 1,290 to 2,180 μ^2, was reduced by this treatment to 125 μ^2. And on further annealing at falling temperature this fine grain was retained until the temperature had dropped below A_1. From this temperature down to about 500 deg. C. the grains grew again, the growth being proportional to the length of annealing time. This grain growth at temperatures below A_1, which is in contradiction to the experimental results of other investigators, was proved by further experiments with black-heart and white-heart iron. The experiments show that it is necessary to avoid annealing malleable cast iron at temperatures below A_1 for too long a time.

The experiences gained in the foregoing experiments with respect to grain growth and grain refining were then applied to the two irons in the unannealed state, and the following procedure was adopted. The irons were annealed at 1,050 deg. C. until the eutectic carbides had decomposed, cooled below A_1, reheated above 900 deg. C. to dissolve the α mixed crystals, again cooled below A_1 and finally annealed for a short time just a little above and then a little below the A_1 point, and then quenched in water. The whole treatment took about 12 hrs. after the maximum temperature was reached. The grain size of the black-heart iron was 125 μ^2, the structure consisted of granular pearlite and temper carbon. The mechanical properties were:—Tensile strength 32.7 tons per sq. in., permanent set limit 21.9 tons per sq. in., elongation on 2.36 in. 5 per cent., impact strength (Izod test-piece without notch) 37.6 ft.-lbs. Samples cooled in the furnace showed lower strength figures. The grain size of the white-heart iron was 285 μ^2, the structure consisted of granular pearlite, temper carbon and slag inclusions. The mechanical properties were:—Tensile strength 29.2 tons per sq. in., permanent set limit 19.7 tons per sq. in., elongation on 2.36 in. 6.65 per cent., impact strength 39.8 ft.-lbs. Apart from the elongation, which is, however, quite sufficient, the properties of the two irons equal those of a good annealed steel casting. The permanent set limit, amounting to over 67 per cent. of the tensile strength, is even higher.

Electric Furnaces in the Iron and Steel Industry.—In "Teknisk Tidskrift," O. Stalhane outlines the development of electric blast furnaces and steel furnaces, with special reference to current practice, and describes the construction of the principal modern furnaces.

British Cast Iron Research Association.

ANNUAL MEETING AND LUNCHEON.

The 12th Annual Meeting and luncheon of the British Cast Iron Research Association was held at the Hotel Victoria, London, on Wednesday, November 1. At the annual meeting, which was purely formal, the retiring President—Sir Harold Hartley, F.R.S.—vacated the chair in favour of Major F. A. Freeth, F.R.S. (Imperial Chemical Industries, Limited), and at the subsequent luncheon Major Freeth presided over a company of about 120, which included representatives of the many interests associated with the use and development of cast iron. Among those present were Lord Melchett, Mr. Thomas Bolton (chairman, British Non-Ferrous Metals Research Association), Mr. R. H. Brackenbury (President, Foundry Trades Equipment and Supplies Association), Mr. A. E. L. Chorlton, M.P. (President, Institution of Mechanical Engineers), Dr. C. H. Desch (National Physical Laboratory), Mr. V. C. Faulkner, Editor of THE FOUNDRY TRADE JOURNAL, Mr. E. J. George (President, National Federation of Iron and Steel Manufacturers), Mr. J. T. Goodwin (Past-President, Institute of British Foundrymen), Mr. P. J. Hannon, M.P., Sir Harold Hartley (Past-President), Mr. James Henderson (United Steel Companies, Limited), Mr. P. V. Hunter (President, Institution of Electrical Engineers), Mr. W. B. Lake (treasurer, Institute of British Foundrymen), Sir William Larke, K.B.E. (National Federation of Iron and Steel Manufacturers), Mr. C. Le Maistre, C.B.E. (British Standards Institution), Sir M. MacDonald (President, Institution of Civil Engineers), Dr. H. Moore (Director, British Non-Ferrous Metals Research Association), Mr. B. Pontifex (Armourers' and Brasiers' Company-Master), Sir Robert Robertson, F.R.S., Dr. F. S. Sinnatt (Fuel Research Board), Sir Frank Smith, K.C.B. (Department of Scientific and Industrial Research), Mr. E. B. Wedmore (Director, British Electrical and Allied Industries Research Association), Mr. H. B. Weeks (chairman of Council, British Cast Iron Research Association), and Mr. J. G. Pearce (Director, British Cast Iron Research Association).

At the conclusion of the luncheon,

SIR HAROLD HARTLEY, F.R.S., in calling upon their new President to give an address, said Major Freeth did not need any introduction, as he was the greatest authority in this country on the phase rule, which was the theoretical basis of the cast-iron industry.

Presidential Address.

MAJOR FREETH, after thanking the members for his election, said that, unlike the great organisation with which his predecessor in office, Sir Harold Hartley, is connected, his company—Imperial Chemical Industries—could not claim to be a large producer of ferrous castings. It was, however, a very large user. Its needs covered a wide range of material and were met by a number of foundries. Since much of this material had to withstand special conditions with respect to corrosion, erosion, heat and mechanical stress, it looked to the Cast Iron Research Association for the progress which makes possible the production of cast irons of even higher grade than they did at present. He believed that it was the duty of all founders to support this Association, and hence put themselves in a position to carry out these developments as and when opportunity offers. The I.C.I. had made large-scale tests of some of the Association's developments, such as Silal and Nicrosilal heat-resisting irons, and he looked forward to further opportunities of testing new materials which the Association would produce. One of these was referred to guardedly in the Report, and in members' own interest he did not propose to particularise, but it offered promise of producing a standard type of cast iron which can act as a basis or datum for various methods which have been evolved for securing a high-quality material. These processes included desulphurisation, degasification, alloy additions of various kinds, together with the process of inoculation by means of which the 30-ton tensile iron has now arrived at commercial production. This was a state of affairs upon which the industry and the Association could be heartily congratulated. As was hinted in the Report, the process cannot yet be applied to the whole range of production, particularly to large castings, and in some castings of widely varying sections it might be unpractical to use it at all. Whilst the designer endeavoured to make the sections of any casting as uniform as possible and to arrange changes in section to be as gradual as possible, the possibility of securing these different sections in one piece formed the very *raison d'être* of the casting itself.

Oil From Coal.

Major Freeth, referring to home-made petrol, said:—Everybody has doubtless heard of the tremendous development which is being sponsored by Imperial Chemical Industries, Limited, for the dous development which is being sponsored by Imperial Chemical Industries, Limited, for the production of oil from coal. The importance of this in some respects cannot be over-emphasised, as the importation of foreign-produced petrol is one of the most considerable individual factors in the British adverse trade balance. The production of home-made petrol, practicable on account of domestic coal supplies, is not only of vast industrial importance, but an occasion may easily arise when it may be essential to national security. In the materials employed in the new plant the fullest possible advantage was being taken of modern metallurgical knowledge.

New Melting Plant.

The Association ought to have an induction melting furnace even if it meant that the Council should go dog-racing or horse-racing to raise the money! It is not right that industry, which resignedly pays taxes and rates to put up the buildings and equipment for technical schools, should deny essentials to the body which is likely to have such a profound effect on its capacity to pay those rates and taxes in future. He learned with particular pleasure of the generosity of the Vice-President, Mr. H. James Yates, in providing funds for a cupola furnace—an essential for which the Association has had to wait too long. Up to June, 1931, ten years after the Association was established, its work was made possible by a Government grant of £1 for £1 on industrial subscriptions. The Government has always, and very rightly, insisted that research associations should be financed by means of regular subscriptions rather than by means of sporadic donations or payments for work actually done, because, more than any other branch of human activity, research must be done steadily and not in jumps. This can only be provided on the subscription basis. It can be greatly assisted by appropriate apparatus and equipment and suitable accommodation and working conditions, but it depends primarily on the intelligence of the investigators.

What Research Is.

Research is essentially exploration, for which the investigator has to fashion his own specially-sensitive and delicate mental instruments. It is like trying to reach the centre of a maze, which can sometimes be found by a happy accident or by sheer good luck, but it is most assured when the side tracks, which so often appear to be the main path, are systematically explored and labelled for future use so as to prevent confusion. It is sometimes like trying to unravel a particularly tangled thread. One tries to release a knot here and fails, and one has to go to another and try that, and suddenly, after many efforts, the whole thing unravels almost miraculously if one has resisted the temptation to cut what may appear to be a loss.

Research Development.

The next difficulty occurs in putting the idea into practice, and cases are well known in which this industrial development has taken many years. One of the great advantages of the Research Association movement has been to diminish this period, in which years have been reduced to months. The development stage, however, equally provides its problems no less difficult in their way than the original research and involving both expenditure and time. The troubles here arise from four main causes. The first is the larger scale on which the work is done; the margins which suffice for laboratory work have to be increased in an ordinary production process for it to be mistake-proof. The mere change in scale also introduces complications. Secondly, the requirements of an individual works are in many respects peculiar to itself, and the original process requires to be modified to suit. Thirdly, on the laboratory scale, for the purpose of making progress at all, it is necessary to simplify the procedure as much as possible. In work on an industrial scale, and particularly in this extremely complex material, many variables come in which have not been allowed for in the original work, and which change from application to application, and these have to be taken into account. Finally, there are the differences in the capacity of various works, which show themselves, for example, in the fact that one works can undertake a development and carry it through quite successfully, whereas another works meets with difficulties, either of personnel or of equipment or control. There may be successful manufacture, but inadequate selling, or *vice versa*, and so on.

Census of Production.

One of my predecessors, Sir Philip Nash, in 1929, quoted an estimate from the Annual Report of that year of the value of the output of this industry considered as castings, the figure being one approaching 40 millions sterling per annum in a normal year. Since this estimate was formulated the Census of Production figures for 1930 have been published, and the output figure for the industry is given, incidentally for the first time, as nearly 26 millions. Bearing in mind the fact that the Census admittedly does not include all establishments, and also the difference between 1930 and a normal year, the estimate is very satisfactory. There is no estimate for the corresponding Census in 1924 for foundries, but the figures exist for the iron and steel trades as a whole, and, assuming that the drop in output is similar in the two cases, in 1924 the value may be taken as 37.5 millions, without taking any account of those establishments not covered by the Census. The estimate is very close indeed. An industry whose products are valued at figures of this order both requires and is able adequately to support a national research organisation such as the Association represents.

Referring to the recent success of the latest attempt made by Mr. Pearce to increase the area of contact between the staff and the members, which took the form of a Study Course in October, Major Freeth said that the numbers greatly exceeded anticipations, and he had had an opportunity of reading a number of letters from members who were represented, expressing their satisfaction with the course in the most enthusiastic terms, and making it clear beyond any doubt that similar provision in future at appropriate intervals would be welcomed. The preparation for this course entailed a large amount of work from the staff, and the results greatly exceeded expectations.

It was constantly urged among scientific people that with the growth of economic nationalism, scientists in various countries do not meet as they ought to, but that, thanks to the Institute of British Foundrymen, the foundrymen of the world were more in contact with each other than is the case in many other branches of industry, and it was only by pursuing such a policy that we can continue to add to general and specialised knowledge.

He concluded by saying that Sir Harold Hartley's period of office had ended on a note which must give you all satisfaction. The financial difficulties caused by the fall in grant would during the coming year, he thought, be entirely overcome, and with the grant situation stabilised for two years, they could look forward to a period of uninterrupted progress. Anything he and the Council could do to promote that would be done.

Research and Industrial Prosperity.

Mr. A. E. L. Chorlton, proposing a vote of thanks to the President, said the British Cast Iron Research Association was doing most important work, and was fortunate to have on its Council and committees very many important people connected with the industry. He regarded invention and research as the two most important points to be attended to in any real recovery of the state of affairs that used to exist. It was quite obvious that it would be impossible in the future to employ anything like the number of men now out of work unless either by invention or research new industries were developed and provided a direct means of fresh employment.

International Conferences.

Another matter had been mentioned by the President, namely, the close relationship between the British scientific associations within the foundry industry and similar organisations in foreign countries. On this general question his own view was that we did not have a sufficient number of international conferences in this country. We had allowed the control of them to escape us, and these conferences were held in Paris and other Continental cities, whilst all the younger nations were also starting in this direction. This, however, was not a proposal of his own, because Sir Frank Smith was strongly of the opinion that definite steps should be taken to bring engineers and chemists all over the world together by setting up an organisation in this country for that purpose and for holding scientific conferences of an international character in London. What was necessary was propaganda to let the world know the position which this country really held in matters of science. Before the war the Germans had secured their high position in industrial life largely by propaganda which created the impression throughout the world that the Germans were the people who had all the scientific and technical knowledge in the world, and that, at any rate, they were in the best position to meet any difficulties. Therefore, it was the duty of this country to let the world know the position of Great Britain in science and technology at the present moment, and one way of doing it would be to arrange for more international conferences to be held here.

Elements of Business.

Lord Melchett, who seconded the vote of thanks to the President, said that he had three principal interests in the Association, namely, soda ash, nickel and Freeth. Taking these in their reverse order, he said his interest in the President, which had now extended over many years, had been because he was a man of extraordinary courage and imagination. He was never frightened by the Hindenberg lines of the unknown scientific world. Major Freeth was always prepared to storm them in some way or another, and it was therefore sincerely to be hoped that the Association would benefit from this contact with his experimental enthusiasm and that Major Freeth would succeed in doing what he did from time to time in I.C.I., namely, to stimulate the desire for research, for its own sake, and a real desire to widen the bounds of knowledge in whatever occupation we might happen to be engaged.

As to the other interests he had mentioned, both soda ash and nickel—which I.C.I. supplied—were used in the manufacture of cast iron, but his company also used castings to a very large extent. Thus, as with all world businesses, the various interests of buying and selling were intimately bound up, and people ought to realise more often than they do in discussions on production and over-production and economic problems generally, that industry is nothing more nor less than a question of the exchange of production. It was merely an exchange of one product for another, although unfortunately from time to time things got a little out of balance. He was one of those, therefore, who believed that experiment is also necessary in the methods of control whereby our economic forces have been managed in the past. There had always been a tremendous amount of "hush hush" about finance and economics, which had been looked upon as one of those mysterious things which only the chosen few could understand. Personally, he did not pretend for a moment to be one of the chosen few. He had, however, for a long time studied the returns of the Bank of England, but had never properly understood them. There was always an item under the heading of "rest," and for years he had looked for an item on the other side under the heading of "unrest," and had never found it. Nevertheless, "unrest" had been observable in varying degrees in the various countries of the world which had suffered from the policies hitherto pursued, but he had never seen it charged as a debit against the bank.

Cast iron had always been used as a simile for something that was tremendously strong and ultimate in its conception of reliability. Those who had any knowledge of engineering, however, knew that it was nothing of the kind; indeed, the very purpose of the existence of the Association was to try and make it so, and from that point of view he was very pleased to see the progress the Association was making. In this connection he suggested that it was necessary to revise our technical ideas, not only from an engineering point of view, but also from an economic point of view, and to realise that the old notions of economic orthodoxy were just about as reliable as the old cast iron that was made 50 years ago. What was needed was a more modern economic orthodoxy to keep pace with modern developments—as the Association was trying to keep pace with modern developments in cast iron—which would have a more profound effect upon the economics of the nation than all the machinations of any central bank.

Position of Britain Industrially.

Continuing, Lord Melchett expressed the view that there were grounds for great satisfaction, at any rate for one thing at the present time, because he did not think Great Britain had had such an opportunity for industrial progress and expansion, since, perhaps, 1900, as it had at the present time. Our competitors were in nothing like such a relatively strong position as they were four or five years ago, and we, with an increasing stability, had a chance of making progress and of outstripping those who would compete with us in the world's markets, such as we had not had for many years past, or were likely to have in the future if our competitors were given the opportunity of again catching us up. Now was our chance and our opportunity, and it was to be hoped that we would take it. At the same time, we must realise that Government and industry had to work more closely together than had been the case in the past. The argument that the business man should be left alone and not interfered with by Government really fell to the ground now, because experience had shown that those industries which had been assisted by the Government had been the most successful. On the other hand, those industries which the Government had not assisted had failed to solve their problems, and there was little doubt, in his opinion, that the Government could help a good deal in the solution of the industrial problems of to-day, always provided that industry was not subjected to any absurd form of bureaucracy or any over-rationalised form of State planning which nobody wished to see.

Co-ordination of Business Interests.

Commenting on the remarks by Mr. Chorlton as to the various technical and scientific associations being under one roof, Lord Melchett said he had always been not only an advocate of that, but of going a little bit further. He would like to see an Industrial Chamber of Parliament in this country, where the industrialists of the nation could get together and discuss their problems, and even though they might not be allowed to put their conclusions into immediate effect, at any rate they could advise the Government as to what ought to be done to extract ourselves from the awful morass of party politics, which was the chief danger in British industry to-day. All these things, however, were a matter of experiment, and it was with the greatest pleasure, concluded Lord Melchett that he seconded the vote of thanks to their President, who was, above all other things in this world, an experimentalist.

The Attitude of the D.S.I.R. to Research.

Sir Frank Smith (secretary, Department of Scientific and Industrial Research), who supported the vote of thanks to the President, said that when Lord Rutherford was in Birmingham a short time ago to open an extension of the laboratories of the Association, he afterwards stated that, whilst he was very pleased with the progress being made, he was, at the same time, very disappointed at the financial support given to the Association. After all, an industry such as the cast-iron industry, based on a large number of units, was essentially one in which there should be co-operation, and Lord Rutherford had remarked that he would like to see all the contributions with an additional 0 added to them. Lord Rutherford had further expressed his regret that for this very reason the whole thing was on too small a scale. Indeed, apart from the I.C.I. and the electrical industry, said Sir Frank, research in this country generally was on too small a scale. As a country we were the greatest industrialists in the world, and it was essential that we must make progress in our industries. It was impossible to stop progress in other countries even if we did so here, and, therefore, our progress must not only be at the same rate as in other countries, but at a greater rate. The Department of Scientific and Industrial Research had always been, and would remain, sympathetic with regard to the Research Association movement, and although he would not say there was a greater activity in research in other countries than here, there was a tremendous progress being made, and a certain ratio of greater progress must be maintained in this country than in other countries if we were to maintain our position. Therefore, he could only hope that in the balance-sheets of those engaged in the industry there would, on the expenditure side in future, be an item for research. He quite understood, of course, that firms like the I.C.I. spent very considerable sums of money on this account, but even the smallest firm ought to put something down for research in the same way that it put down something for insurance and depreciation. An item for research should be provided for as a method of planning for the future.

The President briefly acknowledged the vote of thanks, and the proceedings closed.

Foundry Progress, 1908-33.

PRESIDENTIAL ADDRESS TO YORKSHIRE FOUNDRYMEN.

The opening meeting of the winter session of the West Yorkshire Branch of the Institute of British Foundrymen took place on October 14, at Bradford Technical College, when Mr. R. D. Welford, of Bradford, the new President, occupied the chair. There was an excellent attendance.

MR. R. D. WELFORD, in a brief Presidential address to open the new session, at the outset welcomed the members to a renewal of monthly meetings and expressed gratification at the excellent attendance. His personal view of presidential addresses was that they might be better given at the end, rather than at the beginning, of a session, so that the chairman could, perhaps, review the season's work and achievements. Progress in the Institute of British Foundrymen, whilst it may not be as rapid as some would wish, had undoubtedly been very marked since its humble beginnings, and particularly so of late years. The West Riding Branch, also, had developed exceedingly well since its resurrection, phœnix-like, from the ashes of the old Halifax District Branch. Those who, like himself, had been members of the Institute something like a quarter of a century—he had joined it in 1908—must feel a sense of deep satisfaction and pride in the progress which had been made, though he hoped they were not going to be content to rest on what laurels they had won so far. In 1908, from what could be learned from the published Transactions in his possession from that time onwards, the total membership of the Institute was 331, of whom 34 were honorary and 297 general members. In the local Branch the membership was only 21, of whom 6 were honorary and 15 general. To-day the Institute membership was somewhere about 2,000—a tremendous improvement, though he was not going to claim it was all it should be; and the West Riding Branch membership, if he understood aright, was somewhere between 96 and 100, including associates. This also was a vast growth, yet he would point out, as a call for collective recruiting effort on the part of existing members, that the Branch advance had not been as great as that of the national movement, the area proportion of the whole being only about 5 per cent. to-day, as against 6.4 per cent. in 1908. Mr. Welford said he mentioned these facts as an encouragement for further effort locally, and in no sense in a critical spirit of the excellent work and progress achieved. The progress, indeed, was very wonderful when one recalled that in the period since 1908 probably some fifty foundries had closed down.

There were, suggested Mr. Welford, three main phases in the life of an Institution such as their's—past, present and future. They were all of importance. Much could be learned from the experience of the past, which should be a help in tackling problems of the present and a guide as to the wisest course for the future. They had many things of which they might complain to-day, but by comparison with the condition of affairs in the foundry industry in the early days of the Institute they had now much for which they should be thankful, and for which undoubtedly they had a good deal of cause to thank the Institute and the splendid pioneer workers who had established and built it up. When he first joined the Institute there was little or nothing in the way of technical education available for the ordinary foundryman. Nearly every foundry had pet ideas of its own which it considered far superior to those of any other foundry and guarded jealously. Mechanisation was practically unknown in that period. He was not going to suggest that mechanisation had been an unmixed blessing to the industry. Even to-day, with all its development, he thought foundry owners and employees had gained little from the expansion of mechanisation by comparison with the gain which undoubtedly had come to their customers from it.

A Beneficial Influence.

The Institute, from its foundation in 1904, had had a very wide and beneficial influence on foundry-trade matters and was certainly responsible for the bulk of foundry classes in this country. The members of the Institute could take credit and pride in the fact that but for the work of the organisation of which they were members, the spread of technical knowledge amongst the working foundrymen, and a good deal of research work which had extended the knowledge even of the experts, would not have advanced as far as it had done in this country. The Institute had grown very greatly, but it was still far from the completeness which it deserved and which was essential if it was to be fully effective in all its objectives. Although they could claim some two thousand members, the fact remained that there were many great blanks in potential membership which ought to be filled, and he trusted a big effort in that direction might mark his own period of office as President of the West Riding Branch. To-day, thanks to the Institute, they had systematic foundry classes, diploma courses in practical foundry work and university courses in the scientific side.

The syllabus, one had to admit, might tend to frighten a youth away at first sight, but it was not really anything like so terrible as it seemed, and it certainly was a comprehensive syllabus which meant that the young man who went through with it was bound to be a great deal wiser in his craft, and of more value to his employer, himself and his industry as a result. Mr. Welford said he was afraid not all employers in the foundry industry gave full and adequate consideration to what the Institute had to offer in the way of producing trained young men, and especially as to what the holding of the diploma really meant. Already, however, that diploma was becoming steadily more recognised as a mark of training and a recommendation. One looked forward to the day, which one hoped was not far distant, when every foundryman would be expected to go through a course leading to a qualifying examination which would be a nationally-recognised and admitted standard of skill and technical knowledge. The future of the Institute, as of the industry itself, lay definitely in the hands of the younger men, and those who had spent most of their lives in endeavouring to establish for the rising generation privileges and advantages such as they themselves had never been able to enjoy in their own younger days, looked to those who were gaining the benefit to uphold the honour and integrity of a great and important craft and industry. When the letters M.Inst.B.F. or A.M.I.B.F. carried the same weight as M.I.Mech.E. or other similar qualification, then indeed would the work of the founders of the Institute and those who were carrying on the great task proved justified.

Concluding his address, Mr. Welford presented to the Branch Library his own copies of the Institute's published Transactions from the first issue up to date.

Hearty thanks for the address and the gift were expressed on behalf of the meeting by MR. A. S. WORCESTER (Huddersfield—Immediate Past-President), seconded by MR. H. SAYERS (Leeds—Past-President).

PROBLEMS FROM THE PATTERNMAKER'S VIEWPOINT.

MR. G. COPEMAN, of Leeds, opened a discussion on the subject of "Foundry Problems from the Patternmaker's Viewpoint," and said that he appreciated the opportunity afforded of putting before practical foundrymen a few of the difficulties which confronted the patternmaker. He thought the patternmaker might be regarded as something in the nature of the designer's interpreter; he was the man who had to visualise the finished casting from the work of the drawing office. He had to materialise the thoughts of the designer when he read the drawing and put its message into fact. He had, while reading the drawing, to reflect on the various difficulties which would have to be overcome before the finished casting was produced, and in that respect he must, if possible, have a certain amount of knowledge of the difficulties which the foundryman would have to face and endeavour to simplify them so far as the pattern could achieve that end without departing from the intentions of the designer. As he must contemplate the moulding of the pattern, he must obviously have a knowledge of foundry practice. It would therefore, he felt, be readily understood that a patternmaker who was employed by a firm who made their own castings had a decided advantage over a patternmaker who had to make patterns to send out to other foundries, of whose particular methods he had no knowledge. It was well known that different foundries had different methods, and very rarely, if ever, did one come across two foundries adopting quite parallel methods in every respect. For that reason it was desirable that the patternmaker should have a *general* knowledge of foundry practice and make his patterns as suitable and as simple as possible to meet what he felt was general practice if he were making for other than a single foundry whose methods he knew well.

Meeting Foundry Conditions.

After he had decided on the mould, the patternmaker must settle upon how to build up his pattern. This necessitated a fair amount of experience. There should be as small an amount of end grain as possible. End grain in the wood was liable to cause a bad draw, which would involve rebuilding up certain parts of the mould. The durability of the pattern must also be considered, and it should be built to stand a reasonable amount of rapping, and also aimed to avoid the possibility of twisting and warping. Strip or taper was also an essential factor, but one which was too often neglected, the result being that it created a bad lift, spoiled the mould and thereby added costs to the foundry. Neglect of this factor also put extra weight into the casting and spoiled the finished appearance. A patternmaker who knew his work, proceeded Mr. Copeman, could considerably assist the moulder by coring off certain parts and so saving the moulder from having to make joints and paring down.

In many cases it was cheaper to make a core than to make a joint in the mould. This also assisted in reducing foundry costs by the saving of labour. In his (the speaker's) opinion, a corebox was more important than the pattern, because it had to be made in such a manner that it could easily be fitted together. The best method of making a corebox was to make sure that all the parts were easily dismantled. This may, in some cases, add to the cost of the patternmaking, but any extra cost in that direction was easily counteracted by a saving in the foundry, provided, of course, that the corebox was made as it should be: by a patternmaker who had a general knowledge of foundry practice. Mr. Copeman said he always considered any loose parts in a corebox should be made with a slight taper on them, so that they could be easily withdrawn with the smallest possible amount of rapping. If there was no taper in the corebox a bad draw would probably result, which would mean a new core to be rammed up. Rapping a corebox, also, was detrimental, because the core was apt to become out of shape, which would cause a bad fit in the mould. This may, and

very often did, involve the making of a fresh casting. Rapping, therefore, should be avoided as far as ever possible.

Corebox Development.

Before one could obtain a finished casting, there were many processes through which it had to go after leaving the drawing-office board. Without doubt, the most important process was the pattern and any coreboxes which may be required. As just one illustration of the kind of problems with which the patternmaker was sometimes faced, Mr. Copeman spoke of a particularly intricate job in connection with a steel tube with seven branches. This steel tube had to be cast into a crankcase. This was a job which required a great deal of careful thought and a considerable chance of trouble. As a matter of fact, the finished casting came out satisfactorily and the steel tube was in its correct position. To that extent the problem as it presented itself so far as concerned a practical job was solved. But there remained a good deal of problematic interest in the matter, nevertheless. It was a point which neither he (Mr. Copeman) nor any founder to whom he had put it had yet been able to answer conclusively. If anyone could supply the answer it would be gratefully welcomed. The crankcase was of aluminium, required for a 6-cylinder engine. Running through the full length of the casting was the steel tube, and on this tube were seven steel branches required for oiling the main bearings. The main tube was $\frac{7}{16}$ in. dia. outside. The branches were $\frac{3}{8}$ in. outside dia., and were each welded to the main tube and bent to a 200-mm. radii. The main bearings were supported by a wall 6 mm. thick, and all the tubes were encased in metal 4 mm. thick. The contraction from the first pipe to the seventh pipe was 9 mm. The first difficulty was to get the pipe in, and this was overcome by welding the branches on to the main tube at contraction sizes. This had to be done to get the pipe into the cores, each tube having 1.5 mm. contraction. What neither he nor anybody else had yet been able to solve, however, said the speaker, was, what had happened to the 9-mm. contraction, for the main pipe was straight and all the branches were in the centres of the bearings: and what effect would this have had on the casting?

DISCUSSION.

The ensuing discussion turned chiefly on a good deal of question and answer in regard to minute detail of the problem advanced by Mr. Copeman. Several members offered ideas as to possible explanations or partial explanations, but it had to be generally admitted at the conclusion that the complete answer had not been found. Some members expressed a feeling that it was a puzzle which might never be solved; others agreed that it was too intricate to solve on the basis of verbal description only, without seeing the product itself.

Turning to more general aspects of the relationships between the patternmaker and the foundryman, Mr. S. W. Wise (Hon. Secretary) said Mr. Copeman had given the meeting a general outline of the nature of the points of view which the patternmaker had to keep in mind in preparing the way for the job to be undertaken subsequently in the foundry. As the results of foundry practice depended so much on the quality or otherwise of the pattern, it was a most valuable thing that the members should have learned something of the patternmaker's position and difficulties. Mr. Copeman had put them simply and clearly; better, indeed, than anyone he (Mr. Wise) had previously heard.

Mr. W. G. Thornton (Bradford, Past-President) said he believed this was the first occasion on which the West Riding Branch had had the patternmaker's point of view put to them in so explicit and understandable a manner. It was as well that every foundryman should realise and appreciate something of the patternmaker's difficulties, just as the patternmaker must know something of those of the foundryman. As one who had had some little experience on the patternmaking side himself in past years, Mr. Thornton said he could fully endorse the points stressed by Mr. Copeman. The patternmaker had to visualise from the drawing the designer's intentions, and also the ultimate end of the job; he had to realise the meaning not merely of the particular piece of production with which he was immediately concerned, but its subsequent requirement, and what the designer really wanted, because the draftsman's chief concern was that he knew the shape of the object required, and left the detail to the patternmaker and the moulder. They were the people who had to tackle any practical difficulties that might arise in the course of producing, in fact, what the draftsman created on paper.

Mr. A. S. Worcester (Immediate Past-President, Huddersfield) said the lecturer had pictured the patternmaker as the foundryman would always like him, but not necessarily as one always found him. Unfortunately, the factor of cost and price was to-day a very big one, and sometimes tended to jeopardise the production of the best patterns, and then the difficulties were left for the foundryman to tackle. Mr. Worcester said he had a great respect for the good patternmaker, because he had to be a far-seeing man. He agreed entirely with the remarks of Mr. Copeman on the subject of a taper. Many a patternmaker, he had no doubt, would like to put in a taper, but it would be wrong according to the drawings, and therefore he dare not do so. He certainly felt that a good many patternmakers might put rather more trouble into the making of coreboxes than was sometimes the case.

The President (Mr. Welford) said he wanted to endorse the expression of a real need for the closest possible co-operation between patternmaker and foundryman. A difficulty in the past—and one which it was hoped would gradually be overcome by technical education—was that so few moulders could read a drawing, and therefore they simply had to follow the pattern blindly, with no idea of the intentions of the job. The patternmaker did not always make everything perfect any more than did anybody else concerned in the production of a casting, but, whereas a mistake by a draftsman or a patternmaker may be just an error of judgment, a mistake by the foundryman meant a "waster."

Mr. A. W. Walker (Huddersfield), proposing a vote of thanks to Mr. Copeman, said a fact which should never be forgotten was that the patternmaker was the link between drawing office and the practical engineering side as represented by the foundry. That was a link which ought to be recognised and valued in its true importance. The foundry suffered a good deal from variation of weight, and in a good many cases it was not unjust to suggest that the patternshop was to blame. At the same time, when a foundryman felt like condemning the patternmaker for some such occurrence, it was as well he should bear in mind some of the factors mentioned by Mr. Copeman that day, as showing that things were by no means such plain sailing in the pattern shop as foundrymen may sometimes be inclined to suppose. When they could rely on getting patternmaking such as had been described by Mr. Copeman that evening, there would be little cause for complaint.

Mr. S. Carter (Huddersfield) seconded the vote of thanks, to which Mr. Copeman briefly responded.

Blast-Furnace Capacity.—In a recent issue of "Feuerungstechnik," D. V. Diózeghy deals with the specific capacity of blast furnaces, comparing the consumption of carbon and the output referred to the furnace diameter, on the basis of published data. In the "Rev. techn. Luxembourg," M. Gangler discusses the influence of coke consumption on the utilisation of blast-furnace gases in metallurgical furnaces, with special reference to the reactions and conditions in the furnace and their effect on the composition and properties of the gas produced.

Book Reviews.

Eisen- und Stahllegierungen (Iron and Steel Alloys), by A. Grützner. 1932 Berlin: published by Verlag Chemie, G.m.b.H., Berlin, W.10. Price 32 mk.; bound 36 mk.

This book is the first of its kind to be published, and it will doubtless occupy a place by itself as an international reference book for some years to come. It gives, in tabular form, the analysis protected, properties and uses, the Patent number and the year of application for Patent protection of all the iron- and steel-alloy Patents published in England, France, Germany, Austria, Switzerland and the United States of America during the period 1880 to March, 1932. The tables are very comprehensive, and include iron containing as little as 0.5 per cent. Si or Mn or 0.05 per cent. P or S as alloying elements as well as alloys containing only a small percentage of iron. The alloys are classified on an alphabetical basis under approximately 1,500 headings, the elements present being represented by their respective chemical symbols. Heat-resisting cast irons containing Si, for instance, are to be found under the heading C-Si, whilst more complicated alloys are classified under several headings. Swiss Patent No. 123017 is a good example of the method of classification. This Patent covers an alloy of the following composition:—

C	Cr	Ni	Si	Mn
0.05–1.5	7.00–25.0	0.05–20.0	0.10–3.0	0.10–2.0

This is first classified under the headings:—

C Cr-Ni C Cr-Mn-Ni C Cr-Ni-Si C Cr-Mn-Ni-Si

In the text of the specification it is stated that the alloys may also contain 1 per cent. Mo or V or W, and the Patent is, consequently, also classified under the following twelve headings:—

C Cr-Mo-Ni	C Cr-Mn-Mo-Ni	C Cr-Mo-Ni-Si
C Cr-Mn-Mo-Ni-Si	C Cr-Ni-V	C Cr-Mn-Ni-V
C Cr-Ni-Si-V	C Cr-Mn-Ni-Si-V	C Cr-Ni-W
C Cr-Mn-Ni-W	C-Cr-Ni-Si-W	C-Cr-Mn-Ni-Si-W

An actual test of the efficiency of the classification showed that binary alloys can be traced almost as quickly as one can find a word in a dictionary, whilst an iron alloy, containing five added elements, was traced in approximately two minutes. An alloy, containing C-Al-Cu-Ni-Si-V-W, was traced in four minutes seven seconds, whereas, previous to the publication of this work, such a complicated alloy could only have been found after weeks of searching, if, indeed, it could have been found at all. Twenty-five protected analyses were found without difficulty in twenty-two minutes.

In spite of the fact that this book is written in German, its use should not present any difficulties to anyone unacquainted with that language, and it will prove of great value to patent agents who deal with iron alloys and to all metallurgists. **F. K.**

British Cupola Developments.

The Director of the British Cast Iron Research Association, Mr. J. G. Pearce, gave a Paper on November 4 to the Association Technique de Fonderie entitled "Développements Recents dans la Pratique du Cubilot en Grande Bretagne" (Recent Cupola Developments in Great Britain). The Paper, illustrated by lantern slides, was given in the large lecture theatre of the Ecole Nationale d'Arts et Métiers, Paris. M. Lobstein, President of the Syndicat Général des Fondeurs, took the chair and introduced the speaker, and subsequently an active discussion took place, opened by M. Ronceray. The Paper outlined the tendencies in British cupola design prior to and following the war, and the subsequent development of the soft blast or low-pressure type. It then dealt with the development of the balanced blast cupola by the B.C.I.R.A., some 40 of which are in operation or under construction.

Extraction of Slag from Iron and Steel.

At the autumn meeting of the Iron and Steel Institute held at Sheffield recently, Sir H. C. H. Carpenter, F.R.S. (Acting President) in the chair, Mr. R. Treje and Prof. C. Benedicks presented a Paper on "A method for the Electrolytic Extraction of Slag from Iron and Carbon Steel." We append the authors' conclusions and two appendices (A) on the "Production of Collodion Bags" and (B) on the "Determination of Metallic Iron present in Slag."

A rational electrolytic method for extracting slag inclusions from iron and steel has been worked out. The slag residue obtained is uncontaminated by any iron hydroxide or basic iron salts. In the case of low-carbon contents, the residue may be directly examined under the microscope. In the case of higher-carbon contents the residue contains also cementite. This is, however, removed by using a suitable electromagnet. When strongly-magnetic slag substances occur, such as sulphides, which are attracted by the magnetic field, the separation may be brought about in a solution possessing a suitable magnetic susceptibility ($MnCl_2$).

The electrolysis is performed in a vessel divided into two by a diaphragm. The iron specimen—surrounded by a collodion bag for collecting the slag and which is carried by a floating wooden ring—forms the anode in a bromide solution containing sodium citrate; the cathode consists of a copper plate in $CuSO_4$ solution. This arrangement and choice of electrolytes, on the one hand, prevents any formation of oxygen gas on the anode—which would cause the liquid in the collodion bag to become acid and consequently attack the slag—and, on the other hand, avoids any hydrogen formation on the cathode—which would render the liquid there alkaline, resulting in the precipitation of hydroxides, which would contaminate the slag.

As attack to a certain extent upon the slag must always be expected, a series of solution tests was carried out on MnO—chosen on account of its probably being the least resistant slag component. The liquid finally used attacks MnO even less than does distilled water.

The slag residue obtained is collected by centrifuging in a graduated tube, in which its (loose) volume may be read directly—after purification from small quantities of metallic iron. The slag volume per unit of weight obtained in this manner may be regarded as a characteristic of the material. The slag residue obtained may be directly subjected to microscopical as well as to chemical analysis.

The microscopical examination of the slag residue forms a valuable complement to the ordinary microscopy on a polished surface, and often provides data characterising the material. Thus, in Armco iron, partly deoxidised with aluminium, well-crystallised octahedra of iron aluminate, that is, spinel, were discovered—a mineral not previously observed as a slag inclusion in common steels.

Good agreement was found between the results obtained from the quantitative chemical analysis and those which might be anticipated from a knowledge of the equilibrium conditions. Here, microchemical methods were found advantageous in considerably shortening the time required for the analysis and, particularly, for the electrolysis. The oxygen contents calculated from the quantitative slag composition were found to agree well with those obtained from direct determinations using the vacuum-extraction method. In an analogous way the quantitative recovery of sulphur was checked.

Detailed directions for the application of the method are given.

Appendix.

A.—*Production of Collodion Bags.*

For this purpose the ordinary method for producing dialysis membranes was used. The mode of procedure is as follows:—A short test-tube of fairly large diameter (for instance, length, 13 cm.; dia., 6 cm.) is half-filled with a solution of collodion in alcohol and ether. While pouring out the liquid, the cylinder is rotated so that the entire inside is covered with collodion. When the surplus liquid has flowed off, air is blown into the cylinder to facilitate the drying, the rotation being continued. When the smell of ether has vanished—the alcoholic smell should remain—the film is first loosened around the opening of the cylinder, and may then be detached easily and removed by means of a blunt pair of forceps. The upper part of the bag thus obtained is immediately fitted around a wooden ring. It is then filled with and preserved in water, in which the floating ring carries the bag. This procedure has proved to be very convenient.

Before using a bag, its permeability must be duly checked. The bag is made as thin as possible (otherwise the resistance is unnecessarily high); it should not be prepared too long before it is taken into use. The size of the bag should be adapted to that of the specimen; besides the test-piece it must also hold a certain amount of electrolyte (at least 50 c.cs. in the present experiments).

B.—*Determination of Metallic Iron present in Slag.*

The method used, essentially that recommended by Bohm, is mainly as follows:—Over the slag in the centrifuge cylinder is poured 10 c.cs. of a 10 per cent. copper-sulphate solution, which is diluted to approximately 25 c.cs. The cylinder is corked, and left over-night (or at least 12 hrs.). It is then centrifuged, and the slag is washed twice with cold distilled water. To the copper-sulphate solution, separated off by the centrifuging, is added 5 c.cs. of sulphuric acid, together with a few grains of pure granulated zinc, after which it is boiled until all the copper colour has vanished. The solution is cooled quickly and filtered through asbestos. The filter is washed; the solution is diluted to about 100 c.cs., and is immediately titrated with permanganate, whereby the metallic-iron content is obtained. In order to remove the corresponding amount of precipitated copper—now contaminating the slag—10 c.cs. of 30 per cent. potassium-cyanide solution is poured into the centrifuge cylinder. This is then heated on a steam bath to 80 deg. C. for 3 to 4 hrs., when all the copper is dissolved. The solution should not be too hot, as precipitation may then occur. After centrifuging and washing, the slag is pure, and is transferred into the smaller graduated centrifuging cylinder.

According to Bohm, this treatment should not have any perceptible influence upon the FeO present. According to the authors' experience, MnO, as well as sulphides, however, are perceptibly attacked; the magnetic separation generally renders the chemical method superfluous.

For non-magnetic steels, where the magnetic separation of the metallic residue cannot be used, it is advisable to omit the cyanide treatment, and to determine the copper content chemically and subtract its weight.

Influence of Beryllium on Steel.

DISCUSSION AT SHEFFIELD.

At the Autumn Meeting of the Iron and Steel Institute, held recently in Sheffield, Sir H. C. H. Carpenter (Acting President) in the chair, Mr. J. H. S. Dickenson and Dr. W. H. Hatfield read a Paper on "The Influence of Beryllium on Steel" (see "F.T.J." issues for October 19 and 26). The following extracts are taken from the discussion.

Dr. McCance, in opening the discussion, said the Paper was of interest from two points of view. It was interesting as an addition to the present-day knowledge of one of the rare elements in steel. One thing, at any rate, for which the authors had to be thanked was that they had overcome the difficulties of introducing beryllium into steel. Whether beryllium was likely to achieve any future or not was a matter on which he thought they should not be too hasty in forming a decision. After all, from the price point of view, they had all seen the price of rare elements come down as the commercial demand had increased, and there was no reason to believe that the same effects would not take place with beryllium if a larger demand arose. The actual physical properties of the steel, however, he must admit, did not look very promising. Like all the lighter elements, beryllium depressed change-points very rapidly, with the result that the gamma loop was closed with a very small percentage—0.5 per cent. of beryllium. With 1 per cent., therefore, one was outside that loop, and in a field where refinement of the grain structure could not take place by heat-treatment alone; and if one argued by analogy from the 70 per cent. chromium irons, they belonged to a similar field, and, in the normal state, were very brittle; but in ordinary manufacturing operations the difficulty of brittleness had been overcome, and those alloys were obtained in a perfectly tough and useful form. The same thing might equally apply to beryllium. With a little further experience in the technique of manipulation, it might be possible to overcome that very intense brittleness which it seemed to confer on steel. One property, however, was the age-hardening, but there again the speaker thought similar age-hardening properties could be obtained by other elements at the present time at much less cost, although it would be interesting to study the effect of beryllium on high-speed steel.

Dr. Rosenhain associated himself with much of what Dr. McCance had just said. Personally, he had had a good deal to do with beryllium, and he had also seen some experimental melts of beryllium-iron alloys, which had shown a very interesting and remarkable property; and although he did not for a moment doubt either the accuracy or the value of the work described in the Paper, he would certainly wish to support Dr. McCance's warning that it should not be regarded as a final condemnation of beryllium as a possible element having a value in connection with steel in one form or another. There was, to begin with, the fact that 1 per cent. had been arbitrarily chosen. The authors had had very little choice, but that 1 per cent. might be either far too much or too little. The remarkable function which beryllium performed in nickel and in copper was well known. The age-hardening effect of beryllium in copper was greater than that of any other element in any other metal known, and in nickel it was of the same order. Therefore, one might hope that, if rightly used—if the proper technique and heat-treatment and so on were applied, and the right range of composition found—it might be possible to obtain age-hardening effects of a very marked character indeed, taking into account the fact that one was working on an initially stronger and harder material than copper.

Authors' Remarks.

Dr. Hatfield said the Paper gave the proper point of view of the effects of beryllium on steel and what its service was likely to be to the steel industry. He would like to tell those present that he and his colleagues had had 6 lbs. of beryllium for their experiments, and that the 6 lbs. cost £200. That meant that that beryllium was costing for the purpose over £30 per lb. Therefore, it would be seen that much time must elapse before the matter, from an economic point of view, could become of great interest.

Mr. J. H. S. Dickenson, in reply, said he need only add a word of two to what Dr. Hatfield had said. Neither Dr. McCance nor Dr. Rosenhain would suppose for a minute that in the Paper the authors had left no loophole open for the future possibility of the usefulness of beryllium. Their point—which was made quite clearly—was that, having carried out the experiments at the great expenditure mentioned, they had come to the conclusion that at the present time, and in the circumstances, there was no hope of getting a useful result which would approach justifying the expenditure.

A vote of thanks to the authors of the Paper was then put and carried with acclamation.

Notched-Bar Tests.—In "Metallurgia Italiana," C. Teadoresco makes a statistical analysis of the experimental results of A. Steccanella on the notched-bar test of Mesnager samples with 2- and 3-mm notches with various steels.

This Week's News in Brief.

Trade Talk.

At the Falkirk Dean of Guild Court this week the Abbotshaugh Engineering Company, Limited, was granted lining to proceed with the erection of new shops, consisting of steel-framed buildings with asbestos-slate roofing.

The North Eastern Marine Engineering Company, Limited, Wallsend, has received a contract for conversion to superheating and machinery improvements on the steamer "Beatus," belonging to Seager & Company, Cardiff.

The business formerly carried on by the late Mr. John Rolland, trading under the name of "John Rolland & Company," at Abbey House, 2, Victoria Street, London, S.W.1, is being continued at the same address under the style of John Rolland & Company, Limited.

Consequent to the approval of the plans for the electrification of the Glasgow Subway Railway by the Ministry of Transport, the Glasgow Corporation Transport Committee have decided to award the contract for the bogies and steel underframe for the coaches to Messrs. Hurst, Nelson & Company, Limited, Motherwell.

A co-operative agreement is announced between the Massey-Harris Company, of Toronto, and Messrs. Blackstone & Company, Limited, Stamford, Lincs, under which all the agricultural machinery products of the two companies will be sold in this country through the centralised organisation of Massey-Harris, Limited.

The opening concert of the winter series organised annually by the Smith and Wellstood Works Welfare Club took place on October 30 in the club hall. Mr. J. R. Fyffe Smith, a director of the firm, presided, and in a brief opening speech introduced the Wellstood Concert Party, which comprised artistes well known locally.

Glasgow Corporation Gas Department has accepted the tender of Messrs. Stevensons, Limited, Canal Foundry, Preston, for the supply and erection of the fuel-handling plant at Tradeston Gasworks, Glasgow. The boiler sheds and other necessary ironwork are being supplied by the Lambhill Ironworks, Limited, Glasgow.

The former works of the Campbell Gas Engine Company, Limited, of Halifax, extending over five acres of land, have been sold to Messrs. Lewis J. Ackroyd, Limited, builders, who propose to demolish the place and build houses on the site. The Campbell Gas Engine Works have stood empty since 1928, when the company went into liquidation.

One hundred years of engineering progress by the firm of Messrs. Hick, Hargreaves & Company, Limited, Bolton, manufacturers of turbo-compressors, blowers and exhausters for collieries, etc., and of industrial power plant generally, were celebrated by a dinner at the Midland Hotel, Manchester, on November 2, the guests being engineers drawn from all parts of the country.

The Admiralty have ordered from James Howden & Co., Limited, Scotland Street, Glasgow, a Brackelsberg rotary pulverised-fuel-fired furnace of 1½ tons capacity, to be installed at Chatham Dockyard. The order follows upon an exhaustive investigation by the dockyard official of the methods of melting metal for the production of certain complicated castings which are required to withstand very severe conditions in service.

Messrs. Gleniffer Engines, Limited, Annieland, Glasgow, have secured a series of orders for Gleniffer Diesel engines. One consists of a contract for two four-cylinder 80-h.p. engines for a shallow-draft vessel being built by Messrs. Denny Bros. & Company, Limited, Dumbarton. Another is a large Diesel engine for the South of England, and an eight-cylinder marine Diesel for export to a British Dominion, and a number of engines for yachts.

There is a hopeful outlook at the foundries at Armadale and Bathgate, where all the concerns are modern and exceptionally well equipped for the production of light-steel castings and colliery equipment. These are highly-specialised industries, and at present there is a distinctly hopeful feeling pervading the atmosphere at the works of the North British Steel Foundry, Bathgate; the Atlas Steel Foundry, Armadale; Dixon & Mann, Limited, Armadale; Renton & Fishers, Bathgate; and Bathgate Foundry Company, Limited.

The Villiers Engineering Company, Limited, of Wolverhampton, it is announced, is carrying out extensions to its factory at a cost of about £10,000 in order to meet the increased demand for its products at home and abroad. A machine shop, 253 ft. long and 54 ft. wide, is being erected on land formerly used as a football ground, giving an additional 14,000 sq. ft. of floor space. Plant will be installed for the production of light-weight internal-combustion engines, for motor-bicycles, lawn mowers and adaptable for various other uses.

Messrs. Henry Robb, Limited, Leith, have secured an order to build a sister ship to the "British Coast," the largest coaster motorship in Britain's coastal fleet, for Coast Lines, Limited. The "British Coast" should have been launched on November 2, but owing to weather conditions it had to be postponed. The keel plate of the twin ship was laid by Sir Alfred Read, chairman of Coast Lines, Limited. The new vessel will be 230 ft. in length, with a breadth of 35 ft., and will have a speed of 12 knots. The machinery will consist of Polar Diesel engines built by British Auxiliaries, Limited, Govan, Glasgow, capable of giving 1,250 b.p. normal on twin screws.

Four important orders, one for a motor liner and three for cargo vessels, have been placed with Clyde shipbuilding firms. Messrs. Alexander Stephen & Sons, Limited, Linthouse, Glasgow, are to build a motor liner for the Adelaide Steamship Company, Limited, Adelaide, Australia, and also a cargo steamer of 5,000 tons deadweight capacity for Messrs. Maclay & M'Intyre, Limited, Glasgow, which will be fitted with the new Stephen three-cylinder compound steam engine. The machinery for the 10,000-ton motor liner, consisting of two sets of Burmeister & Wain Diesel engines, will be supplied by Messrs. J. G. Kincaid & Company, Limited, Greenock. Messrs. Maclay & M'Intyre have also ordered 5,000-ton cargo vessels from Messrs. D. & W. Henderson, Limited, Meadowside, Partick, Glasgow, who will supply the engines and machinery, and from Messrs. Lithgows, Limited, Port Glasgow, for which Messrs. David Rowan & Company, Limited, Glasgow, will supply the machinery.

Contracts Open.

Cairo, November 30.—Machine tools, workroom equipment, etc., for the Egyptian Ministry of Education. The Department of Overseas Trade. (Reference A.Y. 12,043.)

Cape Town, November 15.—Iron-clad switchgear, for the Cape Town Electricity Department. The Department of Overseas Trade. (Reference A.Y. 12,040.)

Dublin, November 18.—Iron and steel stores, for the Great Northern Railway (Ireland) Company. Mr. F. C. Wallace, secretary, Amiens Street Station, Dublin.

Dublin, November 20.—Iron and steel stores, for the Dublin Port and Docks Board. Mr. E. H. Bailey, secretary, Port and Docks Office, Westmoreland Street, Dublin.

Johannesburg, December 4.—12 pump trolleys, complete with wheels, axles and ball bearings, 3 ft. 6 in. gauge, together with a number of pressed-steel wheels and wheels and axles, for the South African Railways and Harbours. The Department of Overseas Trade. (Reference G.Y. 13,085.)

London, S.W., November 28.—Supply and laying of 159 ft. of 30-in. and 355 ft. of 60-in. dia. cast-iron flanged water pipes, with bends, etc., for the Borough Council. Messrs. Preece, Cardew & Rider, 8 and 10, Queen Anne's Gate, Westminster, S.W.1.

Southampton.—Pumping unit, for the Corporation Waterworks Committee. Mr. J. Hawksley, waterworks engineer and manager, Civic Centre, Southampton. (Fee £2 2s., returnable.)

Company Reports.

British Oxygen Company, Limited.—Interim dividend on the ordinary stock of 2½ per cent.

Glenfield & Kennedy, Limited.—Interim dividend on ordinary shares of 2 per cent.

Samuel Osborn & Company, Limited.—Profit, £19,550; brought in, £8,804; dividends on the preference shares for the year ended July 31, 1933, £14,366; dividend of 2½ per cent. on the ordinary shares, £5,494; carried forward, £8,494.

Personal.

Mr. W. H. Heeley has relinquished his position as London representative of Messrs. Joseph Stubb, Limited, of Openshaw, Manchester.

Mr. L. W. Bolton, of the British Cast Iron Research Association, has received notification that he is now an Associate Member of the Institution of Mechanical Engineers.

Mr. D. Purvis Todd, of Wemyss, Fifeshire, has been appointed general manager of the United Engineers, Limited, bridge builders and road constructors, Rangoon. For the past 11 years he was chief architect and draughtsman to the company.

Mr. P. Gifford and Mr. J. R. Lee have been appointed to the board of directors of Messrs. David & William Henderson, Limited, shipbuilders and engineers, Glasgow. Mr. Lee is the secretary of the company, while Mr. Gifford is manager of the repairing department.

Addressing a meeting of his supporters in Bellshill this week, Mr. J. Sullivan, ex-M.P. for the Bothwell Division of Lanarkshire, said that a false impression had got abroad about excessive taxation in Scotland and its effect in keeping industry away. He was a member of a committee of the Scottish National Development Council, which took a test audit of taxation in six selected areas in England and six in Scotland. The result was in favour of Scotland by 4s. 6d. in the £.

Mr. Francis Murray, who has been appointed to the position of works' manager of Whyman's Foundry Company, Limited, Warrington, in succession to the late Mr. W. Mitchell, took up his new duties on Monday, October 30. Mr. Murray has had considerable experience in works' management, having been employed by the London Scottish Foundry, Limited, Barking, Essex, for the last 14 years. It is anticipated that under his supervision additional departments will shortly be opened, dealing with permanent finishes for cast-iron articles produced at the foundry. These finishes will include chromium plating and vitreous enamelling, thus further adding to the numerous processes already undertaken. Mr. O. Wade, who has been employed by Whyman's Foundry Company, Limited, for 25 years, has been appointed foundry manager.

Obituary.

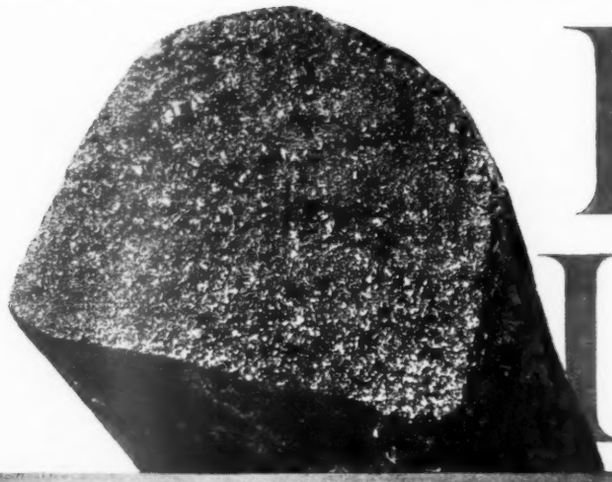
The death occurred suddenly, on October 30, at his home in Carluke, of Mr. Thomas Russell, of the Whiteshaw Foundry, Carluke.

The death occurred, at his home in Glasgow, on October 31, of Mr. Donald M'Intyre, of the Fairfield Shipbuilding & Engineering Company, Limited. Mr. M'Intyre was 57 years of age.

Treasurer Brownlie, Ardlea, Bridge of Allan, has died, following a short illness, at the age of 70. Mr. Brownlie was an engineer by profession, and for about 30 years was manager of Sunnyside Iron Works, Coatbridge.

Mr. James Marshall Aikman, works manager of Messrs. Stewarts and Lloyds' Vulcan Tube Works, Flemington, died on November 1. Mr. Aikman, who was 37 years of age, became unwell on the previous Thursday, and on Tuesday was removed to hospital suffering from diphtheria. He became worse, and died the following morning. Mr. Aikman was a native of Lanarkshire, and had been manager of the works for a number of years.

Mr. Adam Hunter, M.Inst.C.E., a noted civil engineer and outstanding authority on bridge building, died on November 1, at his residence, The Grove, Buchanan Drive, Ratherglen, near Glasgow. Mr. Hunter retired last year after an association of 45 years with the Glasgow firm of Sir William Arrol & Company, Limited, structural engineers and bridge builders. As a youth he gained considerable experience during the construction of the Forth Bridge. His special skill as a designer and builder of bridges became increasingly useful to his firm, and he was rapidly promoted until he was appointed chief designer and director. Mr. Hunter was responsible for the design and construction of many important bridges and other structures at home and abroad. He was in charge of the building of all the main bridges across the Thames in London, with the exception of the most recent, the Lambeth Bridge. He was associated with many important engineering undertakings at home and abroad, and he was repeatedly consulted by engineers in all parts of the country. He was a President of the Glasgow University Engineering Society and President in Glasgow of the Students' Section of the Institution of Civil Engineers.



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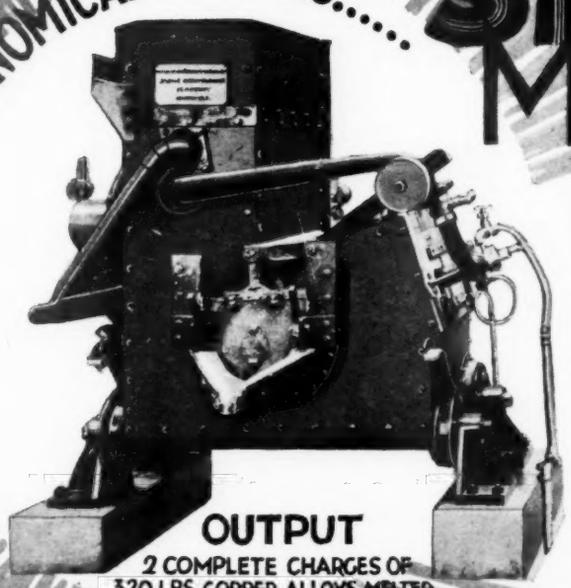

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Raw Material Markets.

THERE is not a great deal of activity as regards foundry iron at the moment, as most of the larger consumers are covered by running contracts. Consumption is maintained at a high level, and what stocks are still in the possession of the furnaces are being rapidly reduced. Additional furnaces will be put into blast shortly, when adequate supplies of coke are assured. Prices are very firm and, although no changes are being made at the moment, an upward movement is anticipated in some quarters. Coke and ore prices continue very firm.

Pig-Iron.

MIDDLESBROUGH.—The Cleveland ironmasters are in a very strong position. They are able to dispose of the whole of their output in the home market at the scheduled prices, and can afford to ignore the considerably lower prices offered in the export markets. Consumers are specifying heavy deliveries against current contracts, and are willing to enter into further forward agreements. The makers, however, are acting with caution, and are not entering into heavy commitments beyond the end of the year. Quotations for No. 3 Cleveland G.M.B. foundry grade remain at 62s. 6d. per ton delivered Middlesbrough, 62s. 3d. delivered Falkirk, 64s. 6d. delivered North-East Coast and 65s. 3d. delivered Glasgow. No. 1 foundry iron is in all cases 2s. 6d. per ton more than No. 3, while No. 4 foundry and No. 4 forge iron are 1s. per ton less.

Consumers of East Coast hematite have shown no hesitation in following the recent rise in price, and are willing to buy forward as freely as the producers will permit. The latter, however, have very little surplus iron for disposal for the next three months or so. Prices are very firm, and another rise is hinted at. Holders of stocks are not inclined to sell at the current rates. These are as follow:—Mixed numbers, 62s. 6d.; No. 1 grade, 63s. per ton, f.o.t.

LANCASHIRE.—The movement of iron into consumption in this area has been slightly accelerated, and a number of foundries report more active conditions, particularly in light-castings and special trades. Conditions in the jobbing section are still rather poor. Quotations are very firm. Midland brands of No. 3 iron—Derbyshire and Staffordshire—are quoted for delivery in the Manchester price zone at 67s. per ton, with Cleveland at about the same figure, Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., Scottish foundry at about 80s., East Coast hematite at 76s. 6d., and West Coast at between 80s. and 81s.

MIDLANDS.—Generally speaking, more active conditions are apparent at consuming works in this area, and the furnaces are sending out heavy tonnages of iron. Many consumers have entered into forward contracts for foundry iron, at present rates, reaching to June, 1934. The furnaces are not prepared to sell any further in advance. Quotations are unchanged, at 62s. 6d. per ton for No. 3 Northants and 66s. for Derbyshire, Lincolnshire and North Staffs No. 3, including delivery to Birmingham and Black Country stations and subject to rebate for large consumers. No difficulty is experienced in getting supplies promptly of ordinary No. 3 foundry. There is a slight improvement in the demand for special irons. Medium-phosphorus pig-iron from various sources is offered at between 70s. and 80s. per ton, with Scottish No. 3 and other low-phosphorus grades between 80s. and 90s., the Scottish figures averaging about 85s. per ton. There is also a little demand for refined iron at between £5 and £6 15s. per ton delivered. The recent advance in the price of Cleveland No. 3 to 72s. 6d. has prevented the renewal of contracts, and not much business will be done in this area at the new level.

SCOTLAND.—The Scottish pig-iron market continues to lag behind other areas in respect of buying activity. Most consumers' order-books do not warrant entering into forward contracts, and hand-to-mouth buying is the general rule. An exception must be made in the case of Cleveland iron, which has been bought fairly heavily by the light-castings makers. There is no alteration to report in prices, No. 3 Scottish foundry being quoted at the official minimum of 65s. f.o.t. furnaces, with 2s. 6d. extra for No. 1. So far there is no change in the prices of No. 3 Middlesbrough, viz., 62s. 3d. f.o.t. Falkirk and 65s. 3d. f.o.t. Glasgow, with Midland iron obtainable at 1s. 3d. per ton less.

Coke.

The general demand for coke is gradually expanding, in accordance with the growing activity in the consuming industries. There has been considerable forward buying of foundry coke in anticipation of a rise in prices. The price of blast-furnace coke has already gone up, but so far there has been no increase as regards the foundry grade. Present quotations for delivery in the Birmingham area are as follow:—Best Durham brands, 36s. to 38s.; other grades, 35s. to 36s.; Welsh coke, 31s. to 45s., according to analysis; Scottish low-ash coke, 38s. 6d. to 40s. per ton.

Steel.

The steady improvement in the position of the British steelworks has continued over the week, and a satisfactory feature has been the placing of several shipbuilding orders, which has encouraged hopes that the trade revival has reached this section of the industry. The market for semi-finished materials has strengthened, and there has been an advance in the minimum rates of a few shillings per ton. Consumers have covered their requirements, but there is a fair amount of miscellaneous buying, which gives the market an appearance of activity. Continental prices have also been advanced, and some business is reported with home consumers in this department of the market. Conditions in the finished-steel branch are less irregular, and reports from most districts indicate that there is a gradual improvement in demand. The home market continues to provide most of the work for the steel mills, but recently export business has increased in volume.

Scrap.

There is generally a steady demand for all grades of cast-iron scrap, except in the South Wales area, where the demand is rather limited and prices have shown a slight weakness. In most other districts, however, business is good and quotations are firm. In the Cleveland area, there is a steady demand for ordinary heavy cast-iron at 47s. 6d. and for machinery metal at 49s. There is a strong demand for light metal, which is now at 42s. per ton. The demand is very consistent in the Midlands, and prices are maintained. In the Scottish market, the founders are unwilling to pay more than 50s. to 51s. 6d. for machinery cast iron, in pieces not exceeding 1 cwt., and for ordinary cast iron 47s. 6d.

Metals.

Copper.—The copper market has shown unsteadiness during the last few days, largely owing to the fluctuations in the dollar exchange. There has been considerable selling on the London market, as part of "hedging" operations against further dollar instability. Copper quotations have hence declined considerably. This week, when the value of the dollar fell drastically, standard copper declined to £31 8s. 9d. per ton—the lowest level seen for some time. The consumption of copper in Europe remains fairly satisfactory. Further conversations have been proceeding in the United States between the N.I.R.A. and the copper interests with regard to agreeing to a "code" for the industry, but so far success has not been reported, and the outlook in that country is very uncertain.

The week's prices have been as follow:—

Cash.—Thursday, £32 10s. to £32 11s. 3d.; Friday, £32 12s. 6d. to £32 15s.; Monday, £32 1s. 3d. to £32 2s. 6d.; Tuesday, £31 8s. 9d. to £31 10s.; Wednesday, £31 17s. 6d. to £31 18s. 9d.

Three Months.—Thursday, £32 12s. 6d. to £32 13s. 9d.; Friday, £32 15s. to £32 17s. 6d.; Monday, £32 3s. 9d. to £32 5s.; Tuesday, £31 11s. 3d. to £31 12s. 6d.; Wednesday, £32 to £32 1s. 3d.

Tin.—In contrast to copper, the price of tin has been very steady, the recent developments with regard to Government control of world supplies having been favourably received. Consumption in Europe is fair. The tin-consuming industries in the United States continue to be very busy, particularly the tinplate mills and motor-car manufacturers.

World consumption of tin continues to be well maintained, according to the latest statistics prepared by the International Tin Research and Development Council. For the year ended August 31, 1933, total world consumption amounted to 118,000 tons, an increase of 18,000 tons over the total for the year ended December 31, 1932. Consumption during August, 1933, was 13,600 tons (preliminary), compared with 6,776 tons in August last year. This increase, it is stated, is due to increased American consumption, which was 16,900 tons (48 per cent.) greater for the year ended August, 1933, than during 1932.

Daily quotations:—

Cash.—Thursday, £224 15s. to £224 17s. 6d.; Friday, £224 17s. 6d. to £225; Monday, £224 15s. to £224 17s. 6d.; Tuesday, £224 15s. to £225; Wednesday, £226 15s. to £226 17s. 6d.

Three Months.—Thursday, £224 7s. 6d. to £224 10s.; Friday, £224 10s. to £224 12s. 6d.; Monday, £224 5s. to £224 7s. 6d.; Tuesday, £224 5s. to £224 10s.; Wednesday, £226 5s. to £226 7s. 6d.

Spelter.—The demand from consumers continues to be disappointing, and although sales are being made all the time, the volume of orders is not satisfactory, report Messrs. Brandeis, Goldschmidt. European stocks of spelter have shown a tendency to increase during the past months, and negotiations are taking place between members of the Cartel for a reduction in output from 50 per cent. to 45 per cent., which was the rate in force until July. It is to be hoped that business will improve sufficiently to render this curtailment unnecessary.

Price fluctuations:—

Ordinary.—Thursday, £15 11s. 3d.; Friday, £15 12s. 6d.; Monday, £15 10s.; Tuesday, £15 8s. 9d.; Wednesday, £15 15s.

Lead.—Heavy arrivals of November metal have depressed values, although selling pressure has not been pronounced. Despite the recent improvement in demand, however, there does not seem to be much resiliency in the market. Taking everything into consideration, the prospects for the metal appear quite favourable, but the behaviour of the market certainly does not bear out this contention, state Messrs. Henry Gardner in their weekly report.

Daily market prices:—

Soft Foreign (Prompt).—Thursday, £11 10s.; Friday, £12; Monday, £11 15s.; Tuesday, £11 15s.; Wednesday, £11 17s. 6d.

Flame-Cutting of Steel.—In view of the increasing importance of electric arc welding, special interest was attached to the Paper, "Flame-Cutting of Steel for Welded Joints," read by Mr. E. J. Clarke, of the Murex Welding Processes, Limited, at a meeting in Glasgow of the Institution of Engineers and Shipbuilders in Scotland.

Mr. Clarke stated that the proved efficiency of arc-welded joints when made in the correct manner with good-quality electrodes, was responsible for the rapid developments of recent times, and there was no doubt that within the next few years welding would revolutionise the methods of preparing and erecting large steel structures, especially in shipbuilding. The designer would have many new problems to contend with, as it was quite obvious that this new form of construction could not be detailed in the same manner as riveted or bolted structures.

A series of experiments had been made to ascertain the effect upon the steel of flame-cutting by oxy-acetylene and oxy-coal gas as compared with machine sawing, and also how these various methods of cutting affected welds made on steel so prepared. It was hoped thus to arrive at definite conclusions on a matter about which there was a wide diversity of opinion. The author stated that having regard to the results obtained in the experiments, the various committees or authorities, that were now drafting or considering regulations for the application of welding would be well advised to consider this very important and economical method of preparing material for welding. Definite recommendations should be made so that the industry might have some lead and therefore confidence in flame-cutting.

NOVEMBER 11 is the last day for receiving proofs in connection with a dividend to be paid by Messrs. Herbert Leathley, 150, Wentworth Terrace, Wakefield Road, Bradford, and Joe Owen Leathley, 9, Gildersome Street, Gildersome, Yorks, carrying on business in co-partnership under the style of "Greystone Foundry Company," at Drighlington, Yorks, ironfounders. The trustee is Mr. J. O. Morris, Hallfield Chambers, 71, Manningham Lane, Bradford, Official Receiver.

Which of these ten advantages would you most welcome?

—they are all incorporated in the Buell system of P.F. firing.

The Buell Combustion
49, MOORGATE, LONDON, E.C.2 Co Ltd
Telephone: Metropolitan 7751 (4 lines).
Works: EDGAR ALLEN & CO., LTD., Imperial Steel Works, Sheffield.

10 Reduction in labour costs 10
9 Increase in furnace outputs 9
8 Ability to use lower and cheaper grades of coal. 8
7 Considerable reduction in metal losses due to scaling. 7
6 Elimination of stand-by losses when furnaces are shut down between turns. 6
5 Greater flexibility and more accurate control of flame conditions and corresponding reduction in furnace maintenance. 5
4 Elimination of laborious cleaning of fires as with hand firing. 4
3 Existing installations show lower fuel consumption between 18 and 49%. 3
2 Absolute reliance on standard number of heats. 2
1 At least 12% reduction in time required for furnace operation attained on *all* converted furnaces. 1

WARNER C.B.R.
CYLINDER
PIG IRON
"The brand of proved reliability"
Supplied to specifications covering a wide range of requirements and employed by the leading Railway Co's Roll Makers and Engineering Founders.
WARNER & CO. LIMITED
CARGO FLEET
MIDDLESBROUGH

RAW MATERIALS—PRICE LIST.

(Wednesday, November 8, 1933.)

COPPER.

	£	s.	d.
Standard cash	31	17	6
Three months	32	0	0
Electrolytic	35	10	0
Tough	34	0	0
Best selected	34	10	0
Sheets	62	0	0
India	44	0	0
Wire bars	36	0	0
Ingot bars	36	0	0
H.C. wire rods	38	0	0
Off. av. cash, October	33	13	10 3/4
Do., 3 mths., October	33	17	2 1/4
Do., Sttlmnt., October	33	14	1 1/4
Do., Electro, October	37	7	0 9/16
Do., B.S., October	36	6	4 5/8
Do., wire bars, October	37	14	6 9/16
Solid drawn tubes			10 1/4d.
Brazed tubes			10 1/2d.
Wire			7d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	8 3/8d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7 3/8d.
Wire	7 3/8d.
Rolled metal	7 1/2d.
Yellow metal rods	4 3/4d.
Do. 4 × 4 Squares	5 1/4d.
Do. 4 × 3 Sheets	5 1/4d.

TIN.

	£	s.	d.
Standard cash	226	15	0
Three months	226	5	0
English	227	5	0
Bars	228	15	0
Straits	231	5	0
Australian (nom.)	—		
Eastern	230	10	0
Banca	230	15	0
Off. av. cash, October	223	10	7 1/2
Do., 3 mths., October	223	8	11 1/2
Do., Sttlmt., October	223	10	10 1/2

SPELTER.

	£	s.	d.
Ordinary	15	15	0
Remelted	15	15	0
Hard	13	10	0
Electro 99.9	18	0	0
English	16	7	6
India	15	10	0
Zinc dust	20	0	0
Zinc ashes	3	15	0
Off. aver., October	16	9	1 1/16
Aver. spot, October	16	6	2 3/16

LEAD.

	£	s.	d.
Soft foreign ppt.	11	17	6
Empire	12	0	0
English	13	5	0
Off. average, October	11	19	0 3/8
Average spot, October	11	16	0 1/2

ALUMINIUM.

Ingots	£100 to £105
Wire	1/1 to 1/9 lb.
Sheet and foil	1/2 to 2/9 lb.

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	25	10	0
Do., V.M. ex whse.	24	10	0
Rods	29	10	0

ANTIMONY.

	£	s.	d.
English	37 10 0 to 40	0	0
Chinese, ex-whse.	26	15	0
Crude	20	10	0

QUICKSILVER.

	£	s.	d.
Quicksilver	9 10 0 to 10	0	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	6 10 0
45/50%	12 10 0
75%	18 2 6
Ferro-vanadium—	
35 50%	12/8 lb. Va.
Ferro-molybdenum— 70/75% carbon-free of Mo.	5/6 per lb.
Ferro-titanium— 23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£14 10 0
Ferro-tungsten— 80/85%	2/6 lb.
Tungsten metal powder— 98/99%	2/9 lb.
Ferro-chrome— 2/4% car.	25 10 0
4/6% car.	23 0 0
6/8% car.	21 2 6
8/10% car.	20 12 6
Ferro-chrome— Max. 2% car.	34 10 0
Max. 1% car.	35 12 6
Max. 0.70% car.	37 10 0
70%, carbon-free	10 1/2d. lb.
Nickel—99.5/100%	£225 to £230
"F" nickel shot	£202 10 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium— 96/98%	2/8 lb.
Ferro-manganese (net)— 76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese— 94/96% carbon-free	1/2 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under 1/2 in. to 1/4 in.	3d. lb.
Do., under 1/4 in. to 1/16 in.	1/- lb.
Flats, 1/2 in. × 1/4 in. to under 1 in. × 1/8 in.	3d. lb.
Do., under 1/4 in. × 1/4 in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.	£	s.	d.
South Wales—						
Heavy steel				2	10	0
Bundled steel and shrngs.	2	2	6 to	2	10	0
Mixed iron and steel	2	5	0 to	2	6	0
Heavy cast iron	2	5	0 to	2	6	0
Good machinery	2	7	6 to	2	10	0
Cleveland—						
Heavy steel	2	7	6 to	2	10	0
Steel turnings				1	11	6
Cast-iron borings				1	2	0
Heavy forge				2	10	0
W.I. piling scrap				2	5	0
Cast-iron scrap	2	7	6 to	2	9	0
Midlands—						
Light cast-iron scrap	1	18	6 to	2	0	0
Heavy wrought iron				2	10	0
Steel turnings, f.o.r.				1	7	6
Scotland—						
Heavy steel				2	7	6
Ordinary cast iron	2	7	6 to	2	8	0
Engineers' turnings				1	15	0
Cast-iron borings				1	15	0
Wrought-iron piling				2	9	0
Heavy machinery	2	10	0 to	2	11	3

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	27	0	0
Brass	19	0	0
Lead (less usual draft)	11	0	0
Tea lead	8	0	0
Zinc	11	0	0
New aluminium cuttings	73	0	0
Braziery copper	25	0	0
Gunmetal	25	0	0
Hollow pewter	140	0	0
Shaped black pewter	100	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	65/-
Foundry No. 3	62/6
,, at Falkirk	62/3
,, at Glasgow	65/3
Foundry No. 4	61/6
Forge No. 4	61/6
Hematite No. 1, f.o.t.	63/-
Hematite M/Nos., f.o.t.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	68/6
,, d/d Birm.	84/6
Malleable iron d/d Birm.	115/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	62/-
,, No. 3 fdry.	66/-
Northants forge	58/6
,, fdry. No. 3	62/6
,, fdry No. 1	65/6
Derbyshire forge	62/-
,, fdry. No. 3	66/-
,, fdry. No. 1	69/-
Scotland—	
Foundry No. 1	67/6
,, No. 3	65/-
Hem. M/Nos. d/d	66/-
Sheffield (d/d district)—	
Derby forge	59/6
,, fdry. No. 3	63/6
Lincs forge	59/6
,, fdry. No. 3	63/6
E.C. hematite	76/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	80/-
Clyde, No. 3	80/-
Monkland, No. 3	80/-
Summerlee, No. 3	80/-
Eglinton, No. 3	80/-
Gartsherrie, No. 3	80/-
Shotts, No. 3	80/-

FINISHED IRON AND STEEL.

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.)	9	0	0 to	9	15	0
Nut and bolt iron	6	15	0 to	7	10	0
Hoops	10	10	0 to	12	0	0
Marked bars (Staffs) f.o.t.				12	0	0
Gas strip	10	10	0 to	12	0	0
Bolts and nuts, 3/4 in. × 4 in.				13	5	0
Steel—						
Plates, ship, etc.	8	15	0 to	8	17	6
Boiler plts.				8	5	0
Chequer plts.				10	7	6
Angles				8	7	6
Tees				9	7	6
Joists				8	15	0
Rounds and squares, 3 in. to 5 1/2 in.				9	7	6
Rounds under 3 in. to 3/8 in. (Untested)		7	2	6	& up.	
Flats—8 in. wide and over				8	12	6
,, under 8 in. and over 5 in.				8	17	6
Rails, heavy	8	5	0 to	8	10	0
Fishplates				12	0	0
Hoops (Staffs)	10	10	0	& up.		
Black sheets, 24g. (4-t. lots)				10	5	0
Galv. cor. shts. (,,)				12	15	0
Galv. flat shts. (,,)				13	5	0
Galv. fencing wire, 8g. plain				14	0	0
Billets, soft	5	7	6 to	5	12	6
Billets, hard	6	17	6 to	7	2	6
Sheet bars	5	0	0 to	5	5	0
Tin bars				5	0	0

PHOSPHOR BRONZE.

	Per lb. basis
Strip	11d.
Sheet to 10 w.g.	12d.
Wire	12d.
Rods	11d.
Tubes	15 1/2d.
Castings	13d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1 1/2 to 1/7 1/2
To 15 in. wide	1/1 1/2 to 1/7 1/2
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2 1/2 to 1/8 1/2
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3 1/2
Ingots rolled to spoon size	10d. to 1/6 1/2
Wire round— to 10g.	1/4 1/2 to 1/11 1/2

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3 1/2 upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	18.26
No. 2 foundry, Valley	17.50
No. 2 foundry, Birm.	13.50
Basic	18.89
Bessemer	19.76
Malleable	19.39
Grey forge	19.39
Ferro-mang. 80%, seaboard	82.00
O.-h. rails, h'y, at mill	40.00
Billets	26.00
Sheet bars	26.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	1.74
Steel bars	1.75
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.60
Steel hoops	1.85
Sheets, black, No. 24	2.25
Sheets, galv., No. 24	2.85
Wire nails	2.10
Plain wire	2.10
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.65

COKE (at ovens).

Welsh foundry	20/- to 25/-
,, furnace	14/- to 15/-
Durham foundry	21/- to 25/-
,, furnace	15/-
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box		17/-
,,	28×20 ,,		34/-
,,	20×10 ,,		24/- to 24/6
,,	18 3/4×14 ,,		17/7 1/2 to 18/-
C.W.	20×14 ,,		15/3 to 15/9
,,	28×20 ,,		32/9 to 33/-
,,	20×10 ,,		23/- to 23/3
,,	18 3/4×14 ,,		16/9 to 17/-

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£6	0	0 to	£7	0	0
Bars-hammered, basis	£16	0	0 to	£16	10	0
Bars and nail-rods, rolled, basis	£15	15	0 to	£16	0	0
Blooms	£10	0	0 to	£12	0	0
Keg steel	£30	0	0 to	£31	0	0
Faggot steel	£18	0	0 to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0 to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Nov.	2 ..	32	10	0	dec.	3/9
,,	3 ..	32	12	6	inc.	2/6
,,	6 ..	32	1	3	dec.	11/3
,,	7 ..	31	8	9	,,	12/6
,,	8 ..	31	17	6	inc.	8/9

Electrolytic Copper.

		£	s.	d.		
Nov.	2 ..	36	0	0	dec.	10/-
,,	3 ..	36	0	0	No change	
,,	6 ..	35	10	0	dec.	10/-
,,	7 ..	35	0	0	,,	10/-
,,	8 ..	35	10	0	inc.	10/-

Standard Tin (cash).

		£	s.	d.		
Nov.	2 ..	224	15	0	inc.	7/6
,,	3 ..	224	17	6	,,	2/6
,,	6 ..	224	15	0	dec.	2/6
,,	7 ..	224	15	0	No change	
,,	8 ..	226	15	0	inc.	40/-

Tin (English ingots).

		£	s.	d.		
Nov.	2 ..	225	5	0	inc.	5/-
,,	3 ..	225	10	0	,,	5/-
,,	6 ..	225	5	0	dec.	5/-
,,	7 ..	225	5	0	No change	
,,	8 ..	227	5	0	inc.	40/-

Spelter (ordinary).

		£	s.	d.		
Nov.	2 ..	15	11	3	No change	
,,	3 ..	15	12	6	inc.	1/3
,,	6 ..	15	10	0	dec.	2/6
,,	7 ..	15	8	9	,,	1/3
,,	8 ..	15	15	0	inc.	6/3

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Nov.	2 ..	18	0	0	No change	
,,	3 ..	18	0	0	,,	,,
,,	6 ..	17	15	0	dec.	5/-
,,	7 ..	17	15	0	No change	
,,	8 ..	18	0	0	inc.	5/-

Zinc Sheets (English).

		£	s.	d.		
Nov.	2 ..	25	10	0	No change	
,,	3 ..	25	10	0	,,	,,
,,	6 ..	25	10	0	,,	,,
,,	7 ..	25	10	0	,,	,,
,,	8 ..	25	10	0	,,	,,

Lead (English).

		£	s.	d.		
Nov.	2 ..	13	0	0	No change	
,,	3 ..	13	10	0	inc.	10/-
,,	6 ..	13	5	0	dec.	5/-
,,	7 ..	13	5	0	No change	
,,	8 ..	13	5	0	,,	,,

AVERAGE MONTHLY PRICES OF WEST COAST HEMATITE MIXED NUMBERS DELIVERED SHEFFIELD.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1894	45 3	45 3	45 1½	45 1	43 11	43 11	43 9½	44 2	44 7½	45 7	43 5	43 3	44 3½
1895	42 8	42 5½	42 6	42 10	43 10	43 7½	44 10	45 11	49 11	48 9	47 7½	47 7½	45 2½
1896	47 0	48 9	48 9	48 2½	47 3	47 3	46 10	46 10	47 2	48 5	50 7	50 6	48 1½
1897	51 2	49 10	48 5	47 4	47 9½	48 6	47 0	47 3	47 3	47 0	48 3½	47 11	48 2
1898	48 9	48 10	49 4	49 8½	50 10	50 3½	51 0	52 5	53 11	55 8	57 3	56 10	52 1½
1899	59 1	59 9	57 7	59 6	64 7	70 10½	76 7½	72 2	74 3	75 0	78 1½	73 3	68 5
1900	75 3½	76 10	79 10	84 6	81 4	79 1½	83 4	81 5	79 11	76 10	77 8½	68 4	78 8
1901	60 2	59 0	57 9½	57 6½	57 8	57 4½	57 8	61 0	60 0½	59 9	58 7½	56 7	58 7½
1902	56 1	57 9½	59 3½	59 9	59 10½	60 0	60 0	60 8½	61 5	61 2	59 3	59 0	59 6
1903	58 5	58 8	61 1	59 5	57 10	57 3	56 7	56 3	55 9	54 8	52 4	52 4	56 8½
1904	52 8½	53 1	53 7	54 9	54 2	53 2½	52 9	52 5	52 2½	52 7	53 1	55 11½	53 5½
1905	57 9½	56 9	58 1	58 2	56 4	55 8	55 5½	56 7	61 0	68 9	69 9	70 11½	60 5½
1906	70 4½	65 2½	63 4½	63 9	64 5	64 6	64 1	66 2½	67 3	69 4½	72 4½	78 8½	67 5
1907	77 9	72 11	71 10	73 9	79 9½	76 9	77 9	78 4	75 11	72 9½	68 6	66 7	74 4
1908	62 7	59 1	61 6½	61 6½	61 4	59 1	57 9½	56 11	60 2	59 2	58 5½	57 7	59 7½
1909	51 4	56 5	55 3	56 1	56 4	57 0	56 8	58 0	61 0	61 1½	60 7½	61 4	58 1½
1910	64 0½	64 3½	66 10½	67 6½	66 2½	65 4	64 4½	65 6½	65 2	64 10½	64 6	65 6	65 4½
1911	66 9	66 1	64 10	63 1	62 1	62 0	61 2	62 2	62 1	61 1	61 10	64 0	63 1
1912	67 0	67 0	67 0	69 3	71 9½	72 11	75 9½	79 1½	82 2½	85 0	85 3½	86 6	75 9½
1913	86 6	86 6	86 3	85 0	83 6½	80 10½	78 1	76 10½	72 6	71 0	68 0	65 3	78 4½
1914	64 6	65 4½	65 6	64 11½	64 2½	64 0	64 0	68 11½	74 6½	71 0	65 4½	69 9½	66 10½
1915	78 9	100 6	103 1	113 6	111 9	114 0	116 3	115 2½	113 8½	121 1½	131 9½	139 6½	113 3
1916	135 0	135 0	133 4	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	129 2½
1917	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1918	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6	127 6
1919	127 6	127 6	127 6	127 6	180 6	184 3	195 4½	204 6	204 6	204 6	204 6	204 6	174 7
1920	224 9	235 0	245 0	275 0	290 0	295 0	295 0	295 0	295 0	295 0	295 0	280 0	284 11½
1921	263 4	228 4	180 0	180 0	180 0	160 0	160 0	157 6	142 0	128 6	121 0	115 6	167 9½
1922	125 0	117 6	115 0	115 0	115 0	115 0	113 1½	104 0	105 0	105 0	106 3	110 0	112 1
1923	109 0½	116 5½	133 11½	138 3½	134 2	125 0	115 7½	111 9	110 0	110 0	113 11	115 0	119 5½
1924	115 0	115 0	114 4½	112 6	112 6	112 6	111 0	110 0	110 0	105 4½	102 6	102 6	110 3½
1925	102 6	102 6	100 0	98 6	97 6	95 1½	92 6	90 6	88 3	87 0	88 1½	88 9½	94 3½
1926	90 1½	90 0	89 8½	89 0	89 0	89 0	90 2½	91 9	94 0	97 2½	*	*	91 0
1927	95 4½	95 6	96 6	95 6	95 3	94 0	92 10½	91 6	90 6	90 6	90 6	89 6	93 1½
1928	85 0	85 3	85 5	85 0	85 3	84 9	84 0	83 9	84 0	84 0	83 1	82 6	84 4
1929	82 10½	83 6	85 0	86 9	87 0	87 0	87 3	87 2½	87 6	89 6	89 6	89 10½	86 11
1930	91 6	91 6	91 6	90 0	89 7½	88 0	87 7½	86 6	86 6	86 6	86 6	86 6	88 6½
1931	86 6	84 6	84 6	84 6	84 6	82 6	82 6	81 6	81 6	83 6	83 6	83 6	83 7
1932	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6
1933	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	83 6	—	—	—

* No prices available.

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG

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